M30-DM 11

US Army Corps
of Engineers
St. Paul District

DESIGN MEMORANDUM NO. 2
FLOOD CONTROL PROJECT

SOUTH FORK ZUMBRO RIVER
STAGE 1B
ROCHESTER, MINNESOTA

20050727 132

FEBRUARY 1987

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190 5th St. E.
St. Paul, MN 55101

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14. ABSTRACT
This design memorandum presents the design improvements for construction of channel modifications and related structures, dam modifications and recreational features along the South Fork Zumbro River and a portion of Bear Creek in Rochester, Minnesota.

15. SUBJECT TERMS
Flood control
Zumbro River
Rochester, Minnesota
Flood damage prevention

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DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U.S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101-1479

REPLY TO
ATTENTION OF

NCSED-M

SUBJECT: Flood Control, South Fork Zumbro River at Rochester, Minnesota, Design Memorandum No. 2, Phase 1B

Commander, North Central Division
ATTN: NCDED
536 South Clark Street
Chicago, Illinois 60605-1592

1. Subject design memorandum is submitted in accordance with ER 1110-2-1150.

2. This design memorandum presents the design of improvements for construction of channel modifications and related structures, dam modifications, and recreational features along the South Fork Zumbro River and a portion of Bear Creek in Rochester, Minnesota.

3. I have met with officials from the city of Rochester to discuss project cost sharing. The city understands and fully supports this project. It has indicated its interest in participating in cost sharing at the percentage of total project costs that conforms to the cost-sharing policy for flood control projects in the Water Resources Development Act of 1986, Public Law 99-662.

1 Encl (16 cys)
FDM No. 2

JOSEPH BRIGGS
Colonel, Corps of Engineers
Commanding

FLOOD CONTROL
SOUTH FORK ZUMBRO RIVER AT
ROCHESTER, MINNESOTA

DESIGN MEMORANDUM NO. 2
STAGE 1B

DESIGN MEMORANDUM SCHEDULE

Number	Scheduled Completion	Submitted NCD	Submitted OCE	Approved
1 - Phase 1 General	Aug 77	Aug 77		Apr 79
1 - Phase 2 General	Sep 82	Sep 82		Feb 83
2 - Stage 1B	Dec 86	Feb 87		
3 - Stage 2	Feb 88			
4 - Stage 3	Oct 88			
5 - Stage 4	Oct 88			

PERTINENT DATA

Project Document - House Document 93-156, 93rd Congress, 1st Session.

Project Authorization - 1986 Water Resources Development Act (Public Law 99-662).

Project Purpose - Flood control.

Location - Rochester is in Olmsted County in southeastern Minnesota on the South Fork of the Zumbro River, a tributary of the Mississippi River.

Hydrology and Hydraulics	
Watershed drainage area	304 square miles
Design flood frequency (when combined with system of seven headwaters reservoirs planned by the Soil Conservation Service)	0.5 percent
Design flows	
Silver Lake Dam to Silver Creek	22,000 cfs
Silver Creek to Bear Creek	21,500 cfs
Upstream of Bear Creek	16,800 cfs
Principal Items of Work	
Channel improvement	
Earth lined	0.5 mile
Riprap and gabion lined	6.1 miles
Concrete lined	0.9 mile
Dredged	0.5 mile
Drop structures	6
New levees	
Primary levees	1.9 miles
Tieback levees	0.5 mile
Dam modifications	1
Relocations	
Bridge modifications	15
Bridge replacements	6
Utility crossings	12
Bicycle and hiking trails	6 miles
Economics	
Federal first cost	$50,700,000
Non-Federal first cost	17,100,000
Total first cost	67,800,000
Average annual operation and maintenance cost	163,500
Total average annual cost	5,723,000
Average annual benefits	7,886,000
Benefit-cost ratio	1.4

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SOUTH FORK ZUMBRO RIVER AT
ROCHESTER, MINNESOTA

DESIGN MEMORANDUM NO. 2
STAGE 1B

SCOPE AND LOCATION

1. The local flood protection project at Rochester, Minnesota, is divided into five stages of construction (see plate 2). This DM (design memorandum) presents the design and discussion of planning for Stage 1B, which consists of channel modifications to the South Fork Zumbro River and a portion of Bear Creek and modifications to Silver Lake Dam. The work includes the dam modifications, scour protection at six bridges, approximately 8,507 feet of channel modifications, replacement of an existing storm sewer, construction of headwalls for existing storm sewer outlets, and construction of approximately 1 mile of bicycle trail.

PROJECT PLAN - GENERAL

2. The five construction stages (as discussed in the GDM (general design memorandum)), are as follows: three stages on the South Fork Zumbro River and one stage each on Cascade and Bear Creeks. Also included are recreational facilities (trails and bridges), an environmental mitigation plan, and aesthetic considerations.

DEPARTURES FROM APPROVED GDM

3. The design presented here essentially conforms to that shown in the GDM. Changes since the completion of the GDM are as follows:

a. The sheet-pile tie-back wall on the right channel bank between the railroad bridge (station 174+43) and Center Street (station 185+00) has been changed to riprap shore protection.

b. Bicycle underpasses have been added at Seventh Street N.E., Center Street, and Third Avenue S.E.

c. Minor changes have been made to the alignment of the channel through Silver Lake in two locations, and the channel bottom has been narrowed.

d. From Silver Lake to Seventh Street (stations 151+30 to 156+70), the channel bottom width has been increased from 175 feet to 225 feet.

e. The channel bottom has been lowered and narrowed from Seventh Street to the power plant dam (stations 157+35 to 169+60).

f. From stations 169+40 to 174+79, shore protection has been changed from sheet pile and riprap to a floodwall.

g. The channel alignment for the downstream end of Bear Creek has been changed to more closely follow the existing channel alignment.

In addition to the changes made in this feature DM, recreational and aesthetic features will be added at the request of the city of Rochester.

HYDROLOGY AND HYDRAULICS

4. DM No. 1, General, Phase I, Plan Formulation includes hydrologic data for the South Fork Zumbro River at Rochester. An updated discharge-frequency curve and data for the 1978 flood of record are in that report. Appendix A of this DM presents the final hydraulic design for Silver Lake Dam and the channel modifications. It includes descriptions of a sediment transport analysis and a cost-effectiveness analysis. An operating plan for Silver Lake Dam and a explanation of maintenance requirements for the channel are also in appendix A.

GEOLOGY

5. A description of the geology for the project area is in the GDM and in appendix B of this report. Appendix B also discusses geotechnical testing of soils, subsurface conditions, slope stability analyses, soil parameters for engineering computations, and soil characteristics that will affect construction.

DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

CHANNELS

6. Channel improvements on the South Fork Zumbro River will extend from the North Broadway Street bridge upstream 8,007 feet to the Third Avenue S.E. bridge. Through Silver Lake, the channel will be dredged 1 foot to 5 feet below its present elevation. The excavated channel will have a bottom width of 175 feet. From Silver Lake to station 168+70, the channel will have a bottom width of 170 to 225 feet and riprapped side slopes of 1V (vertical) on 3H (horizontal). At station 168+70, the slope protection will change to sheet pile tie-back walls and concrete retaining walls. The sheet-pile walls and concrete slope protection will extend to station 186+70, except from stations 175+50 to 185+00 where the right channel bank will be protected with riprap at 1V on 2 1/2 H side slopes. From station 186+70 to 204+00, the channel slope will be protected with bedding, riprap, and rockfill.

7. The channel will also be modified on the lower 650 feet of Bear Creek downstream of the Fourth Street bridge. From the mouth of the creek to station 5+10, the channel will be lined with riprap and will have an 80-foot bottom width and 1V on 3H side slopes.

BRIDGES

8. Six bridges will be modified as part of this feature. Scour protection will be provided at the North Broadway; Seventh Street N.E.; Dakota, Minnesota & Eastern Railroad; Center Street; Third Avenue S.E.; and Fourth Avenue S.E. bridges. Concrete scour protection and gabion protection for the abutments and piers will be constructed at the North Broadway bridge. Wingwall extensions, concrete scour protection, and riprap will be added under the Seventh Street N.E. bridge. Concrete scour protection will be constructed, and bedding and gabions will be placed under the Dakota, Minnesota & Eastern Railroad bridge. Existing stone walls on the right bank both upstream and downstream of the Center Street bridge will be removed and replaced with concrete wingwall extensions. Concrete slope protection and gabion placement will also be used under the Center Street bridge. Bedding and riprap will be placed at the Third Avenue S.E. bridge, and bedding and gabions will be placed at the Fourth Avenue S.E. bridge.

SILVER LAKE DAM

9. Modifications to the Silver Lake Dam are required for hydraulic and structural design considerations. These modifications include partial removal of the spillway and replacement with a movable hinged leaf gate, rehabilitation of the existing tainter gates and bays, upstream apron and concrete repairs, relocation of the equipment house and construction of a new access bridge, and rehabilitation of the stilling basin. Additional details can be found in Appendix A, Hydraulic Design; Appendix B, Geotechnical Design; and Appendix C, Structural Analysis and Design. Appendix A also contains an operating plan and a description of maintenance requirements for the dam.

FLOODWALLS

10. Reinforced concrete retaining walls will be constructed on the right channel bank between stations 169+40 and 174+79 and on the left bank between stations 202+90 and 204+95. Sheet-pile floodwalls will be constructed on the left bank from stations 172+37 to 182+60 and from stations 184+75 to 186+25. Existing stone walls located intermittently between stations 125+70 and 193+45 will be removed. Existing concrete walls on the left bank between stations 126+30 to 126+80 and 203+50 to 204+95 and wood walls on the left bank between stations 174+05 and 176+30 will also be removed.

BICYCLE PATH AND UNDERPASSES

11. A bicycle path will be constructed on the right bank of the Zumbro River from Seventh Street N.E. to Third Avenue S.E. and Fourth Street S.E. (total length is approximately 1 mile). Bicycle path underpasses and approaches will be constructed at Seventh Street N.E., Center Street, and Third Avenue S.E.

POWER PLANT INTAKE AND OUTLET

12. The power plant dam (dam Z-2) at station 170+00 will be removed. A log skimmer will be constructed in front of the power plant intake on the left bank near station 169+50. A gate well (gate well A) will be installed as a

modification to the power plant outlet. A 48-inch RCP (reinforced concrete pipe) and a bulkhead will be removed at the diffuser box (station 159+90).

SANITARY SEWERS AND STORM SEWERS

13. Approximately 2,800 feet of 15-inch sanitary sewer will be constructed along the right bank of the South Fork Zumbro River from Seventh Street N.E. to Center Street; the existing sanitary sewer will be removed or abandoned. The existing 8-inch and 10-inch siphons at station 156+33 will be replaced with twin 10-inch siphons.

ENVIRONMENTAL ANALYSIS

ENVIRONMENTAL SETTING

14. Land use in this reach of the South Fork Zumbro River is a mix of residential, light industrial, and commercial development. Some riverfront park areas are present. Woodlands are characteristic of an urban environment; they are highly disturbed with little understory and limited to one to two trees in width. The park areas are thinly to moderately wooded with well maintained lawns. Tree species present include American elm (Ulmus americana), box elder (Acer negundo), sugar maple (Acer saccharum), basswood (Tilia americana), green ash (Fraxinus pennsylvanica), cottonwood (Populus deltoides), and black willow (Salix nigra).

15. Silver Lake supports a fairly good sport fish population. Common species include bass, crappie, sunfish, perch, bullhead, and channel catfish. Overall, population growth in the lake is considered poor when compared with natural Minnesota lakes because of heavy siltation and the high nutrient load. However, the lake is an important recreation resource and receives heavy fishing use because of its urban location.

16. Silver Lake is an important wintering area for thousands of Canada geese because of the year-round open water provided by the thermal discharge from the power plant. In mid-winter, the goose population averages 15,000; peak populations are 30,000. Most of the geese migrate north around the end of March or the beginning of April. A resident population of about 200 remains and nests locally.

ENVIRONMENTAL IMPACTS

17. Construction of the proposed features will cause the loss of streambank vegetation. Mitigation will be provided with the acquisition and development of lands adjacent to the Keller Wildlife Management Area just southwest of Rochester. Development on the acquired lands will include plantings and trails. The mitigation feature will be designed in conjunction with the design work for reach 2A.

18. Channel construction will cause the loss of instream habitat. Mitigation features include construction of a low-flow channel in other reaches and placement of large riprap along the low-flow channel to provide instream habitat. The low-flow channel will be allowed to stabilize before the large

riprap is placed. It will take 3 to 5 years for the channel to stabilize. More detailed information concerning aquatic mitigation features will be presented in DM's for the reaches where low-flow channel work is proposed.

19. Project constructibility (appendix E) identifies the need to dewater Silver Lake to excavate the channel bedrock upstream of the reservoir. The need to draw down Silver Lake was not identified in previous planning or design studies, because the extent of bedrock was not known at that time. Drawdown of Silver Lake would result in the loss of the existing fishery population. The Minnesota Department of Natural Resources has indicated that its opinion (see letter in appendix G) is that the drawdown of Silver Lake would require mitigation, most likely in the form of restocking the lake and 3 to 5 years of monitoring the population after stocking to ensure successful reestablishment. An appropriate environmental document will be prepared after further evaluation of the significance of this impact.

20. The overwintering concentration of Canada geese on Silver Lake is regionally significant. Silver Lake's importance increases as open water areas near Rochester begin to freeze. By mid-November, Silver Lake is the only open body of water in the area. To minimize disturbance to overwintering geese, any dewatering will be completed by late October and the lake will be allowed to refill by 1 November. Dam modifications will be done during the winter. Construction at the damsite will not appreciably affect the use of the lake by the geese.

21. Chemical analysis of soil borings taken on the left bank at about station 175 indicate the possibility that some soils in that reach may be contaminated with hazardous waste, specifically creosote. Special handling procedures will be required during excavation of soils at this site. The extent of contamination and handling requirements for excavated material will be determined through coordination with the Minnesota Pollution Control Agency.

CULTURAL RESOURCES

22. In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places was consulted. As of January 1987, no properties on the list or eligible for the list will be affected by the project in reach 1B. No sites identified during the cultural resource surveys are within reach 1B. Therefore, no further archeological work is needed in this part of the project area.

RECREATION, LANDSCAPE DEVELOPMENT, AND AESTHETIC CONSIDERATIONS

23. Approximately 1 mile of bicycle trail will be constructed as part of this feature. A landscape development plan has not been completed yet; one will be developed before plans and specifications are prepared. Details on recreation, landscape development, and aesthetic considerations are in appendix F.

24. In its 23 January 1987 letter, the city of Rochester expressed concern about aesthetics and landscape development. A copy of this letter is in appendix G.

SOURCES OF CONSTRUCTION MATERIALS

RIPRAP, BEDDING, AND FILL FOR GABION BASKETS

25. Riprap, bedding, and fill for gabion baskets of adequate quality can be obtained from two quarries in the Shakopee and Oneota formations within 15 miles of Rochester.

CONCRETE AGGREGATE

26. Concrete aggregate of adequate quality can be obtained from two quarries in the Shakopee and Oneota formations within 15 miles of Rochester.

ROCKFILL

27. Rockfill of adequate quality can be obtained from two quarries in the Shakopee and Oneota formations within 15 miles of Rochester.

REAL ESTATE REQUIREMENTS

28. Rochester will be required to provide, without cost to the United States, all lands, easements, and permanent and temporary rights-of-way for construction and subsequent maintenance of the channel, dam, sanitary sewer, and bicycle paths. Local interests will also be required to provide the rights-of-way for suitable borrow areas (including the right to remove material) and areas for the disposal of all unsuitable materials. Rochester will comply with the provisions of the Uniform Relocation Assistance and Real Property Acquisitions Policy Act of 1970 (Public Law 91-646), including appraisals; relocation payments; and, for partial takings, a determination as to whether the remaining parcel constitutes an uneconomic remnant.

29. The city will remove an existing building at Second Street N.E. (station 177+50).

RELOCATIONS

UTILITIES

30. Local interests will make all necessary relocations of utilities in the project area. The utilities, which include electric power, telephone, gas, sanitary and storm sewer, and water lines, are scattered along the project alignment.

ROADS AND BRIDGES

31. No new bridges or road raises are required as part of Stage 1B. Rochester is planning to replace the existing Third Avenue bridge, at the upstream limits of the reach, as recommended in the GDM.

COORDINATION

32. During the development of this DM, considerable coordination was required with the city and adjacent landowners. As previously stated in this report, the city's concerns regarding aesthetic issues will be resolved during the preparation of the contract plans and specifications and acquisition of necessary rights-of-way. The city's 18 October 1985 letter of intent indicated the city's support for the project and its intention to provide 25 percent of the total project costs (excluding recreation). A draft LCA (local cooperation agreement) will be submitted to the Assistant Secretary of the Army (Civil Works) in February 1987. Copies of pertinent correspondence are in appendix G.

COST ESTIMATE

33. The estimate of costs in this feature DM is based on October 1986 price levels and reflects recent prices for similar work in the St. Paul District. The following table presents a cost estimate for Rochester Phase 1B. Also shown is an estimate of the local share of costs. The cost sharing is based on 25 percent of total costs in accordance with the 1986 Water Resources Development Act (Public Law 99-662). A detailed estimate of Rochester Phase 1B costs is included in appendix D.

Table 1 - Summary comparison of estimated first costs

Item	Estimate from 1982 GDM (adjusted to Oct 86 price levels)	Revised estimate (Dec 86 price levels)
First cost		
Construction cost		
Channels	$8,118,000	$7,718,000
Relocations (Federal)	386,000	1,491,000
Recreation	124,000	355,000
Engineering and design	899,000	1,126,000
Supervision and administration	732,000	771,000
Inspection	(385,000)	(422,000)
Overhead	(347,000)	(349,000)
Lands and damages	902,000	403,000
Relocations (non-Federal)		
Utilities	14,000	342,000
Roads and bridges	754,000	0
Channel	0	2,000
Total first cost	11,929,000	12,208,000
Federal/non-Federal breakdown (1)		
Federal first cost		
Flood control		8,893,000
Recreation		178,000
Total		9,071,000
Non-Federal first cost		
Flood control		2,960,000
Lands and damages		(403,000)
Relocations		(344,000)
Cash contribution		(2,213,000)
Recreation		177,000
Total		3,137,000

(1) In accordance with the 1986 Water Resource Development Act.

The difference in project first costs (an increase of $279,000), not including cash contributions between this design memorandum cost estimate ($12,208,000) and the estimate from the GDM dated September 1982 ($11,929,000) is attributable to the following:

a. Channels -$400,000

(1) Increase, refined design of sheet pile and concrete floodwalls, recomputed quantities for sheet pile, including dewatering costs (+1,949,000)

(2) Decrease, refined design of channel excavation, dredging, slope protection, removals, etc. (- 872,000)

(3) Increase, Silver Lake Dam-based on 1985 analysis, and including dewatering costs	(+ 311,000)
(4) Decrease, gabion protection included in relocations in this design memorandum estimate	(- 357,000)
(5) Increase, restoration of railroad and wood bridges not identified in GDM	(+ 109,000)
(6) Decrease, refined design of outlet modifications	(- 553,000)
(7) Increase, additional drainage facilities required as a result of refined floodwall design	(+ 5,000)
(8) Decrease, dewatering costs not included as separable item in this design memorandum estimate	(- 540,000)
(9) Decrease, landscaping not included as separable item in this design memorandum estimate	(- 188,000)
(10) Decrease - winter shelters included as incidental to Silver Lake Dam modifications	(- 264,000)
b. Relocations (Federal): Increase, three bridges added to reach, more extensive scour protection as a result of refined design dewatering costs being added	+1,105,000
c. Recreation: Increase, addition of bicycle path underpasses	+ 231,000
d. Engineering and design: Increase, direct proportion of estimated construction costs	+ 227,000
e. Supervision and administration: Same as (d)	+ 39,000
f. Lands and damages: Decrease, resulting from reevaluation of required real estate based on refined design	- 499,000
g. Relocations (non-Federal)	- 424,000
(1) Utilities - Increase, refined design included more utilities, including sanitary sewer from Center Street to Seventh Street	(+ 328,000)
(2) Roads and bridges: Decrease, Third Avenue S.E. bridge removal not included in FDM	(- 754,000)

(3) Channel: Increase, building removal required by refined design (+ 2,000)

CURRENT BENEFIT-COST ANALYSIS

34. The benefit cost-ratio for the project at October 1986 price levels, an interest rate of 8 5/8 percent, and cost sharing as defined by the 1986 Water Resources Development Act is in the following table.

Table 2 - Benefit-cost ratio

Item	Amount
Federal	
First cost	$46,600,000
Interest during construction	1,968,000
Total	48,568,000
Non-Federal	
First cost	
Cash contribution	6,610,000
Other costs	8,890,000
Interest during construction	375,000
Total	15,875,000
Annual charges	
Federal	
Interest	4,189,000
Amortization	1,000
Non-Federal	
Interest	1,369,200
Amortization	300
Maintenance and operation	163,500
Total	5,723,000
Average annual benefits	
Flood control	7,730,000
Recreation	156,000
Total	7,886,000
Benefit-cost ratio	1.4

SCHEDULE FOR DESIGN AND CONSTRUCTION

DESIGN

35. Plans and specifications for Stage 1B are scheduled for completion in the first quarter of fiscal year 1988.

CONSTRUCTION

36. A continuing contract for Stage 1B construction is scheduled to be advertised in June 1988. Construction should start in August 1988 and continue for about 29 months.

FUNDING SCHEDULE

37. On the basis of the revised estimate for this DM and the current schedule for completion of the project, the Federal funds required (by fiscal year) are as follows:

Funds allocated to date (30 September 1986)	$3,119,000
Fiscal year 1987	678,000
1988	3,000,000
1989	6,800,000
1990	16,800,000
1991	15,000,000
1992	5,303,000

OPERATION AND MAINTENANCE

38. Local interests will be responsible for the O&M (operation and maintenance) of the project. O&M will consist of periodic inspection of the channel, structures, and dm and periodic dredging of the channel. O&M instructions for Silver Lake Dam are in appendix A. Additional instructions will be provided to appropriate local officials for the remainder of the project upon completion. These procedures will ensure proper O&M of this stage until completion of the project.

RECOMMENDATION

39. I recommend approval of the plan for Stage 1B, South Fork Zumbro River at Rochester, Minnesota, flood control project as presented in this feature DM.

Joseph Briggs
Colonel, Corps of Engineers
District Engineer

DRAWING SCHEDULE

DRAWING NO.	SHT.	TITLE
M30-R-10/ 1	1	GENERAL PLAN & DRAWING SCHEDULE
M30-R-11/ 1	2	RIGHT-OF-WAY STA. 126+00 TO STA. 136+00
M30-R-11/ 2	3	RIGHT-OF-WAY STA. 136+00 TO STA. 148+00
M30-R-11/ 3	4	RIGHT-OF-WAY STA. 148+00 TO STA. 160+00
M30-R-11/ 4	5	RIGHT-OF-WAY STA. 160+00 TO STA. 171+50
M30-R-11/ 5	6	RIGHT-OF-WAY STA. 171+50 TO STA. 183+50
M30-R-11/ 6	7	RIGHT-OF-WAY STA. 183+50 TO STA. 194+00
M30-R-11/ 7	8	RIGHT-OF-WAY STA. 194+00 TO STA. 205+67
M30-R-11/ 8	9	RIGHT-OF-WAY STA. 0+00 TO STA. 6+55
M30-R-11/ 9	10	RIGHT-OF-WAY DATA SETS
M30-R-11/10	11	RIGHT-OF-WAY DATA SETS
M30-R-64/ 1	12	TYPICAL SECTION STA. 126+90 TO STA. 168+40
M30-R-64/ 2	13	TYPICAL SECTION STA. 168+40 TO STA. 182+60
M30-R-64/ 3	14	TYPICAL SECTION STA. 186+20 TO STA. 198+60
M30-R-64/ 4	15	TYPICAL SECTION STA. 198+60 TO STA. 203+40 & STA. 1+95 TO STA. 6+15
M30-R-64/ 5	16	PLAN & PROFILE STA. 126+00 TO STA. 136+00
M30-R-64/ 6	17	PLAN & PROFILE STA. 136+00 TO STA. 148+00
M30-R-64/ 7	18	PLAN & PROFILE STA. 148+00 TO STA. 160+00
M30-R-64/ 8	19	PLAN & PROFILE STA. 160+00 TO STA. 171+50
M30-R-64/ 9	20	PLAN & PROFILE STA. 171+50 TO STA. 183+50
M30-R-64/10	21	PLAN & PROFILE STA. 183+50 TO STA. 194+00
M30-R-64/11	22	PLAN & PROFILE STA. 194+00 TO STA. 205+67
M30-R-64/12	23	PLAN & PROFILE STA. 0+00 TO STA. 6+55
M30-R-40/ 1	24	SILVER LAKE DAM PLAN & UPSTREAM ELEVATION
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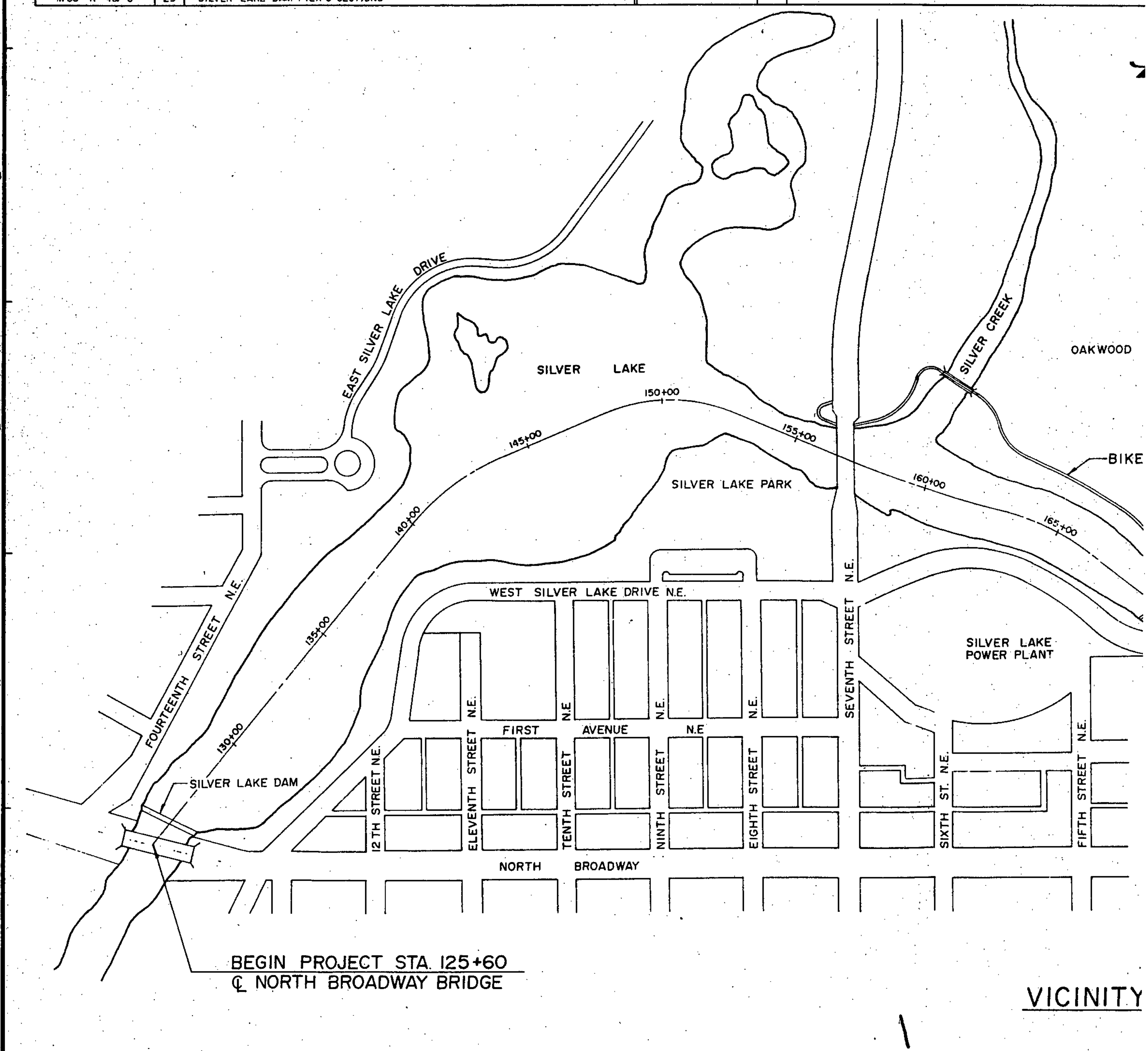
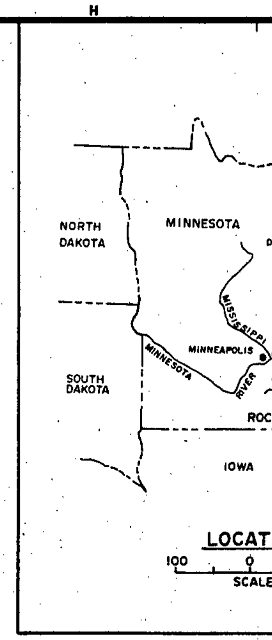
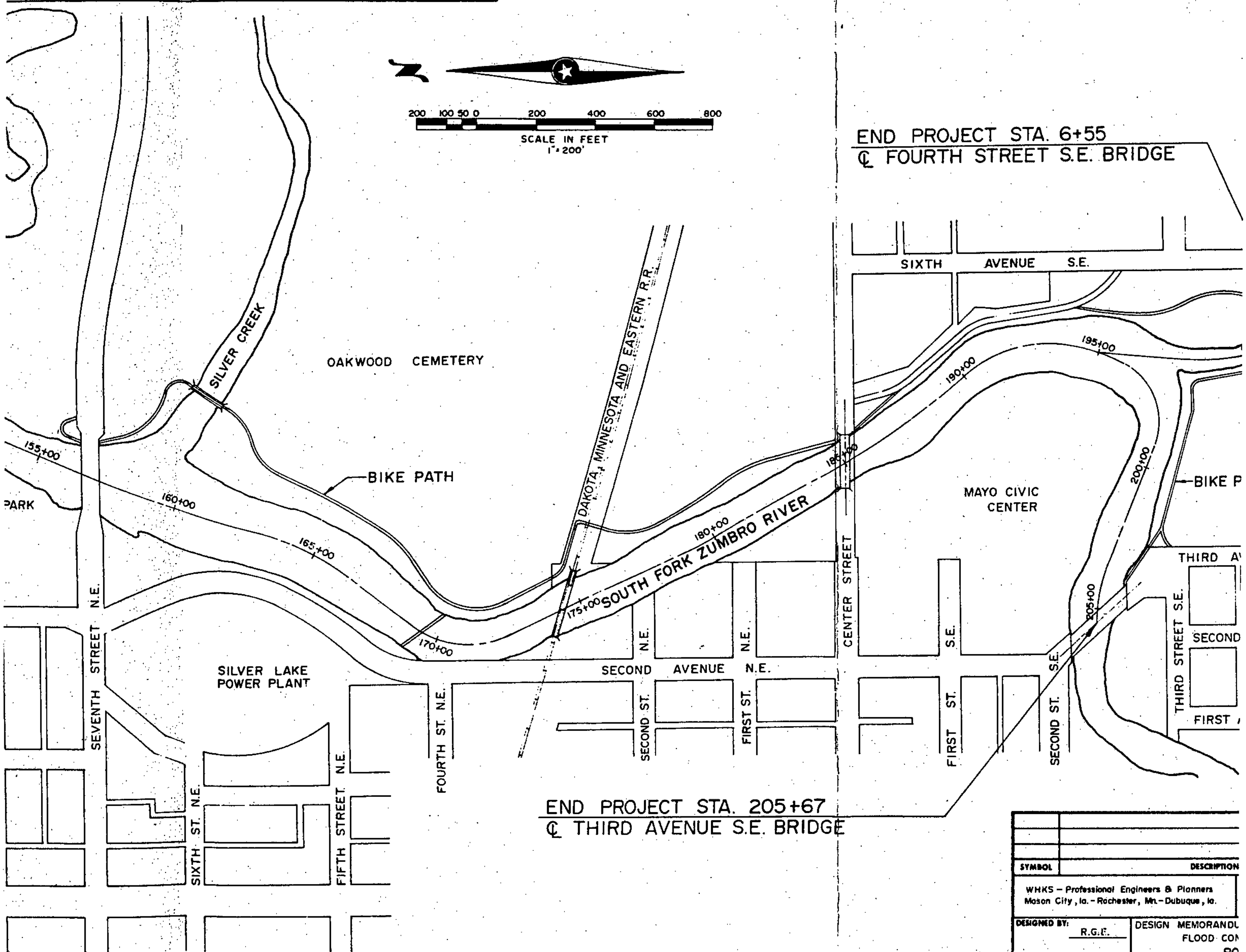
M30-R-40/ 3	26	SILVER LAKE DAM RIGHT ABUTMENT PLAN
M30-R-40/ 4	27	SILVER LAKE DAM RIGHT ABUTMENT SECTIONS
M30-R-40/ 5	28	SILVER LAKE DAM PIER 3 PLAN
M30-R-40/ 6	29	SILVER LAKE DAM PIER 3 SECTIONS
M30-R-40/ 7	30	SILVER LAKE DAM ACCESS BRIDGE & DETAILS
M30-R-40/ 8	31	SILVER LAKE DAM MECHANICAL PLAN & SECTIONS
M30-R-40/ 9	32	SILVER LAKE DAM MECHANICAL PLAN & SECTIONS
M30-R-40/10	33	SILVER LAKE DAM MECHANICAL
M30-R-40/11	34	SILVER LAKE DAM
M30-R-40/12	35	SILVER LAKE DAM
M30-R-40/13	36	SILVER LAKE DAM
M30-R-61/ 1	37	BROADWAY ST. BRIDGE SCOUR PROTECTION
M30-R-61/ 2	38	SEVENTH STREET BRIDGE SCOUR PROTECTION
M30-R-61/ 3	39	DAKOTA, MINNESOTA & EASTERN R.R. BRIDGE SCOUR PROTECTION
M30-R-61/ 4	40	CENTER STREET BRIDGE SCOUR PROTECTION
M30-R-61/ 5	41	LT. BANK & RT. BANK FLOODWALL STA. 126+23 TO STA. 126+58 & STA. 125+73 TO STA. 126+58
M30-R-61/ 6	42	RIGHT BANK FLOODWALL STA. 169+40 TO STA. 174+79
M30-R-61/ 7	43	LEFT BANK FLOODWALL STA. 172+40 TO STA. 186+25
M30-R-61/ 8	44	DETAILS
M30-R-61/ 9	45	BIKE PATH UNDERPASS CENTER STREET BRIDGE



VICINITY

SHT.	TITLE
0	SILVER LAKE DAM ACCESS BRIDGE & DETAILS
1	SILVER LAKE DAM MECHANICAL PLAN & SECTIONS
2	SILVER LAKE DAM MECHANICAL PLAN & SECTIONS
3	SILVER LAKE DAM MECHANICAL
4	SILVER LAKE DAM
5	SILVER LAKE DAM
6	SILVER LAKE DAM
7	BROADWAY ST. BRIDGE SCOUR PROTECTION
8	SEVENTH STREET BRIDGE SCOUR PROTECTION
9	DAKOTA, MINNESOTA & EASTERN R.R. BRIDGE SCOUR PROTECTION
0	CENTER STREET BRIDGE SCOUR PROTECTION
1	LT. BANK & RT. BANK FLOODWALL STA. 126+23 TO STA. 126+58 & STA. 125+73 TO STA. 126+58
2	RIGHT BANK FLOODWALL STA. 169+40 TO STA. 174+79
3	LEFT BANK FLOODWALL STA. 172+40 TO STA. 186+25
4	DETAILS
5	BIKE PATH UNDERPASS CENTER STREET BRIDGE





VICINITY MAP

SYMBOL	DESCRIPTION

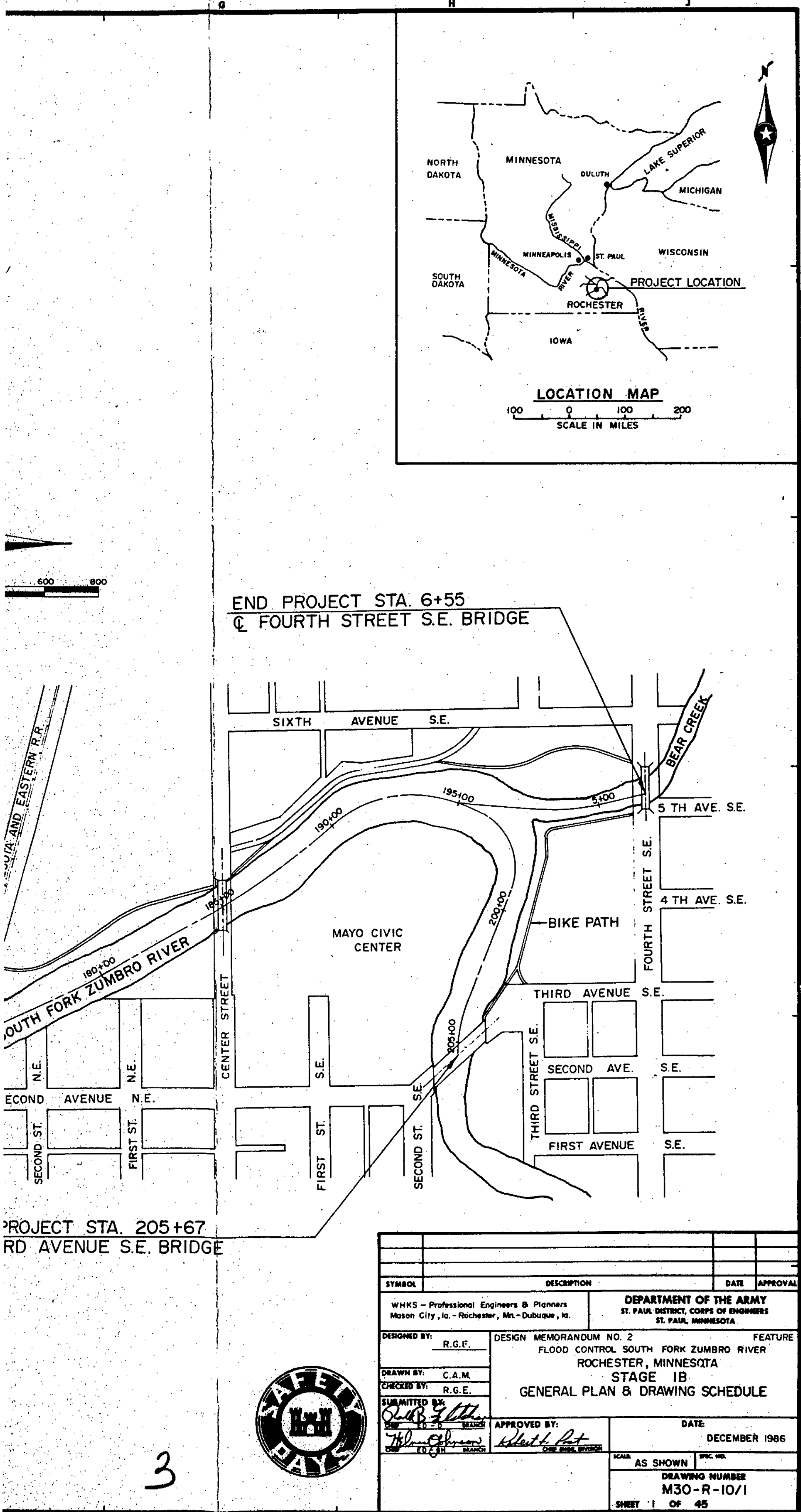
WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DESIGNED BY: R.G.E.
DRAWN BY: C.A.M.
CHECKED BY: R.G.E.
SUBMITTED BY:
APPROVED BY:

DESIGN MEMORANDU
FLOOD CO
RO
GENERAL P

SAFETY PAYS

2

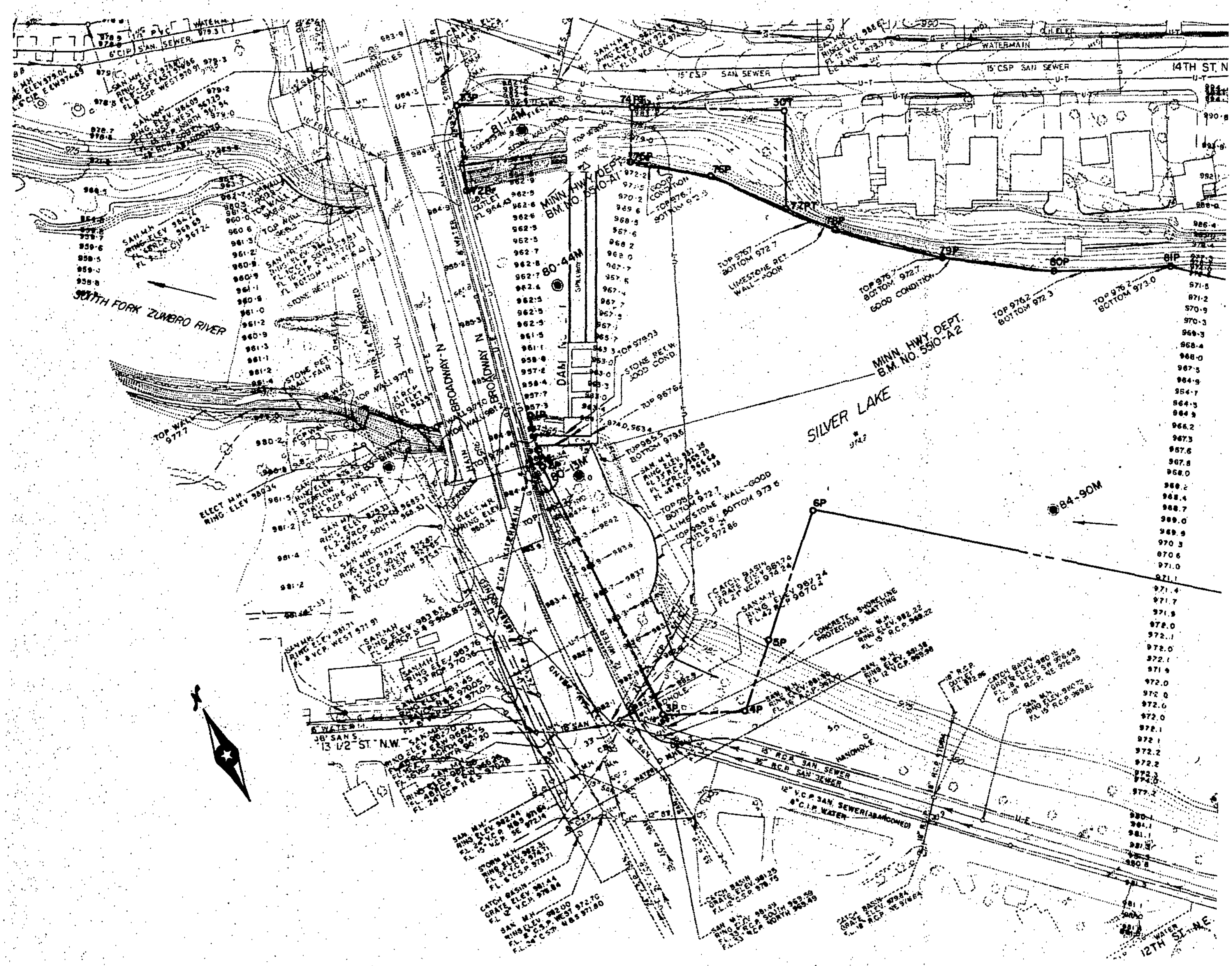


NORTH DAKOTA
MINNESOTA
DULUTH
LAKE SUPERIOR
MICHIGAN
MISSISSIPPI
MINNEAPOLIS
ST. PAUL
WISCONSIN
MINNESOTA RIVER
SOUTH DAKOTA
PROJECT LOCATION
ROCHESTER
RIVER
IOWA
LOCATION MAP
100 0 100 200
SCALE IN MILES
600 800
END PROJECT STA. 6+55
℄ FOURTH STREET S.E. BRIDGE
SIXTH AVENUE S.E.
BEAR CREEK
5 TH AVE. S.E.
4 TH AVE. S.E.
FOURTH STREET S.E.
BIKE PATH
MAYO CIVIC CENTER
SOUTH FORK ZUMBRO RIVER
CENTER STREET
THIRD AVENUE S.E.
SECOND AVE. S.E.
FIRST AVENUE S.E.
THIRD STREET S.E.
SECOND ST. S.E.
FIRST ST. S.E.
SECOND AVENUE N.E.
SECOND ST. N.E.
FIRST ST. N.E.
...SOTA AND EASTERN R.R.
PROJECT STA. 205+67
RD AVENUE S.E. BRIDGE
SYMBOL
DESCRIPTION
DATE
APPROVAL
WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
DESIGNED BY: R.G.E.
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
GENERAL PLAN & DRAWING SCHEDULE
DRAWN BY: C.A.M.
CHECKED BY: R.G.E.
SUBMITTED BY:
APPROVED BY:
DATE: DECEMBER 1986
SCALE AS SHOWN
DRAWING NUMBER
M30-R-10/1
SHEET 1 OF 45
SAFETY PAYS

3

PLATE 1

A B C D E

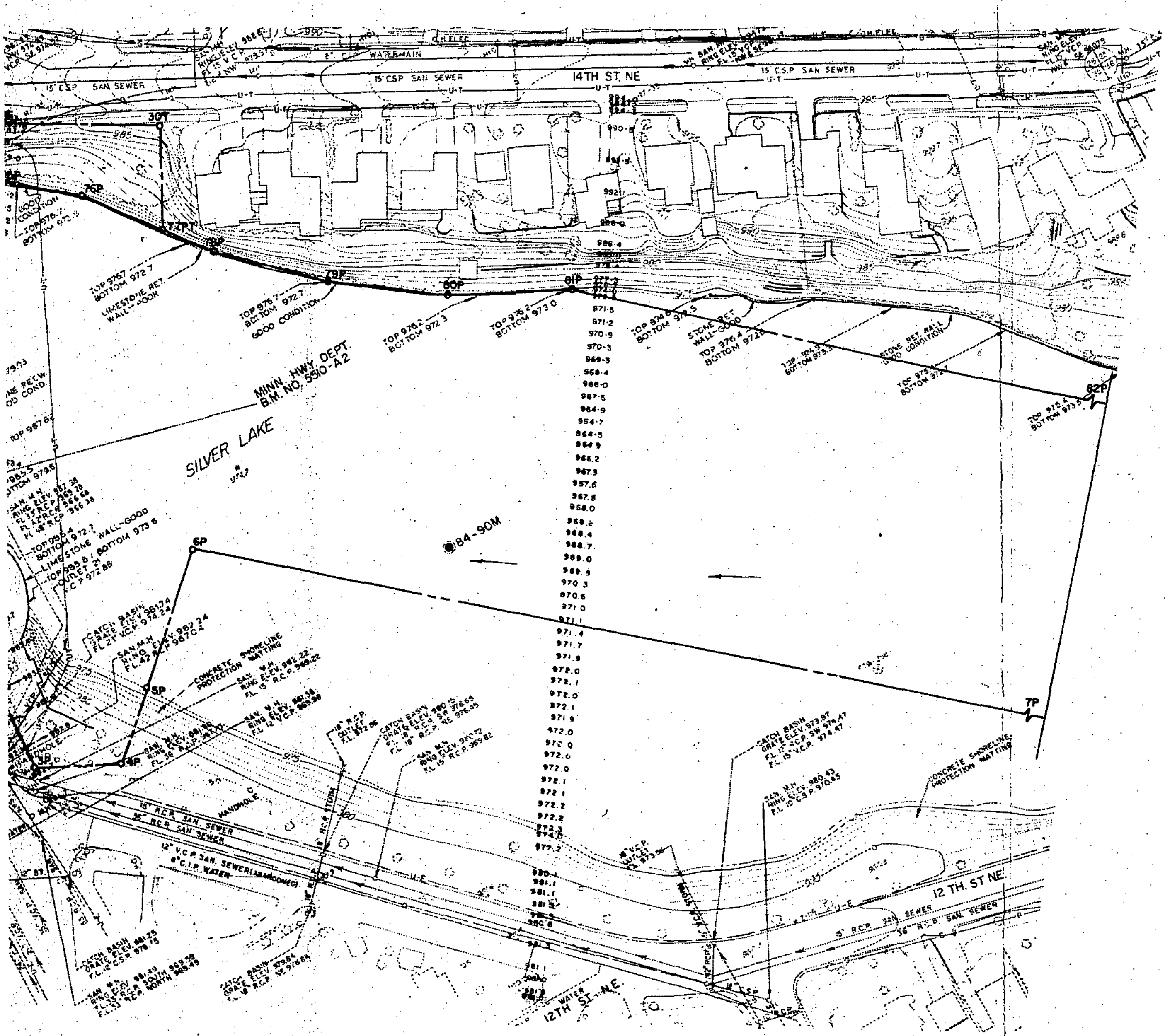


PLAN

50 0 50 100

SCALE IN FEET

A B C D E



PLAN

50 0 50 100
SCALE IN FEET

7P INDI
(7F

SYMBOL

WHKS – Professional Engi
Mason City, Ia.– Rochester

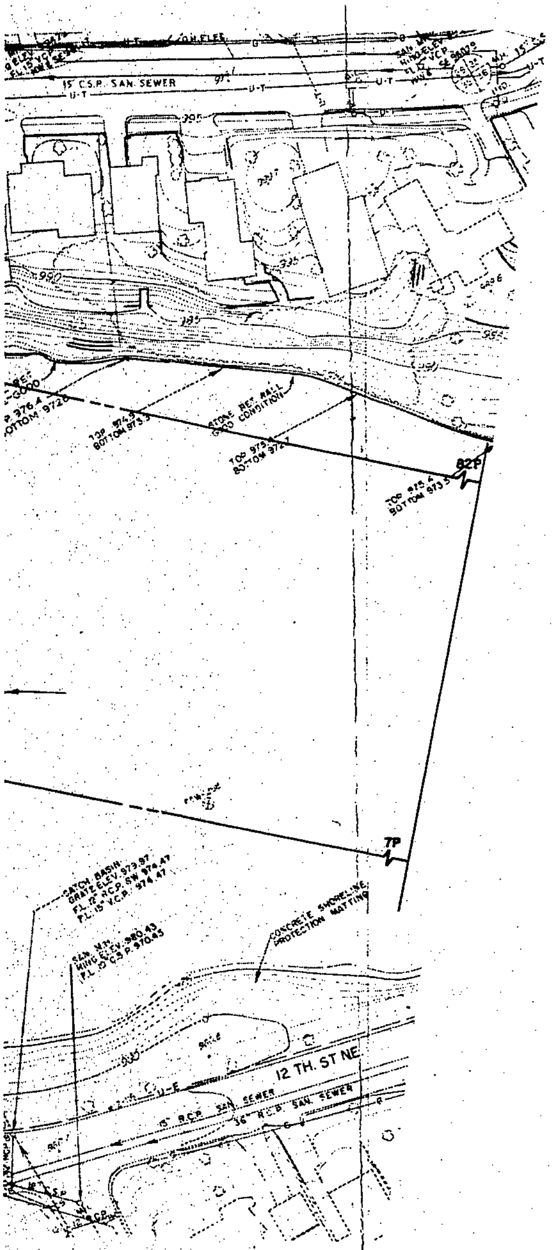
DESIGNED BY: R.G.E

DRAWN BY: K.R.R.

CHECKED BY: R.G.E

SUBMITTED BY:

2



——— — — ——— PERMANENT RIGHT-OF-WAY

——— — — ——— TEMPORARY RIGHT-OF-WAY

7P INDICATES THAT THE NEXT RIGHT-OF-WAY POINT (7P) IS SHOWN ON ANOTHER DRAWING

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.G.E
DRAWN BY: K.R.R.
CHECKED BY: R.G.E
SUBMITTED BY:
APPROVED BY:

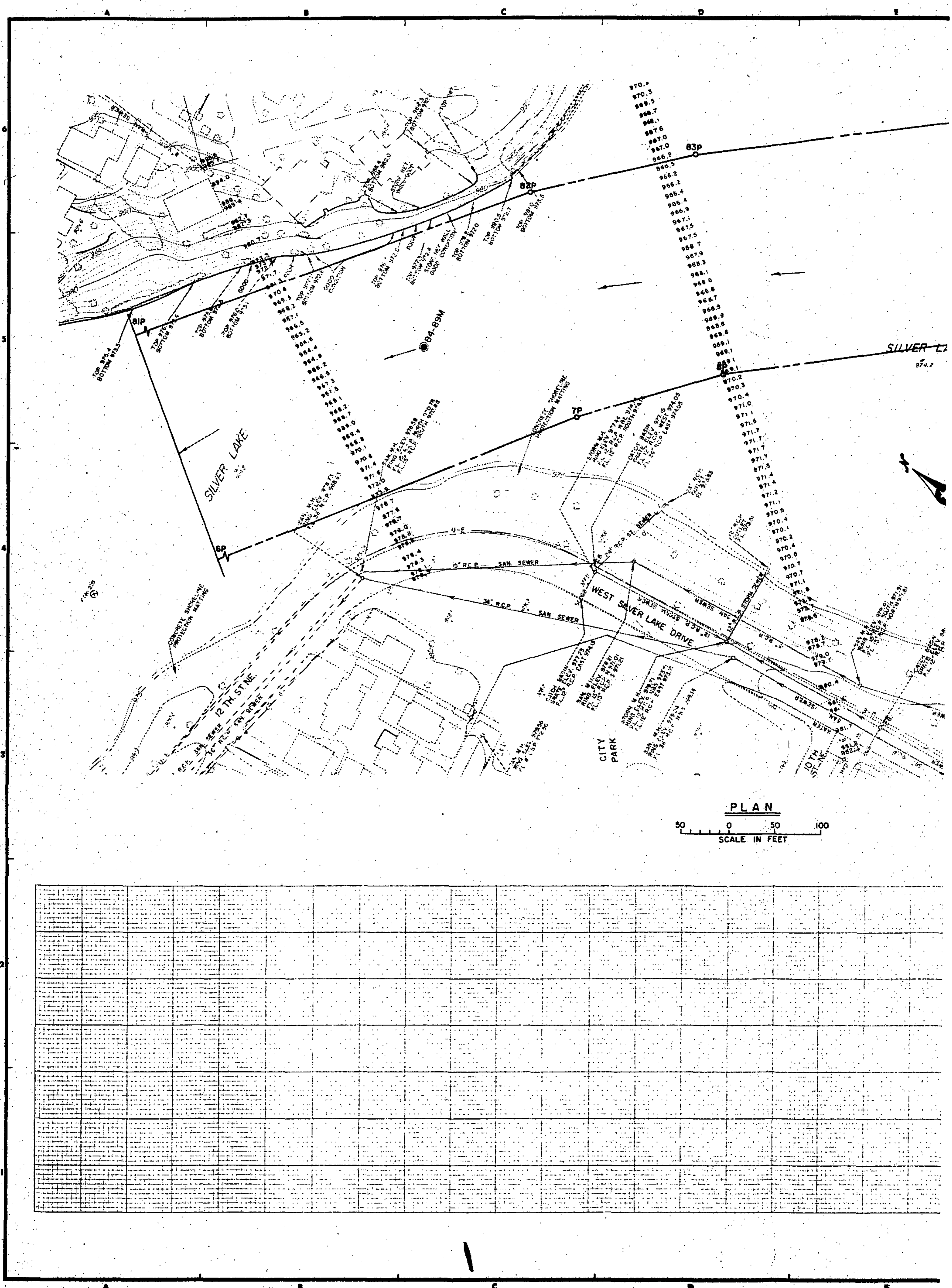
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
RIGHT-OF-WAY
STA. 126+00 TO STA. 136+00

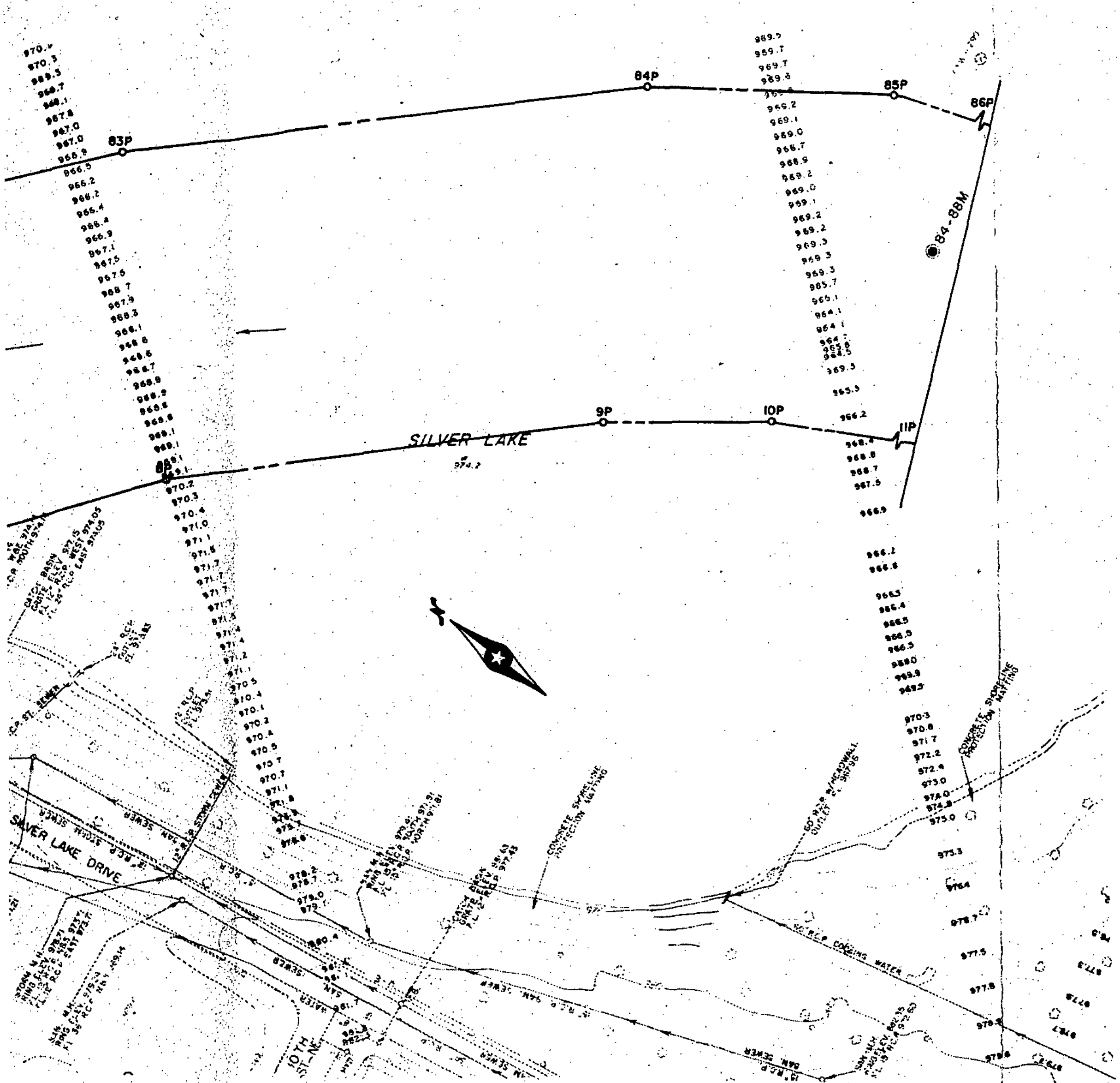
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-11/1
SHEET 2 OF 45

SAFETY PAYS

3

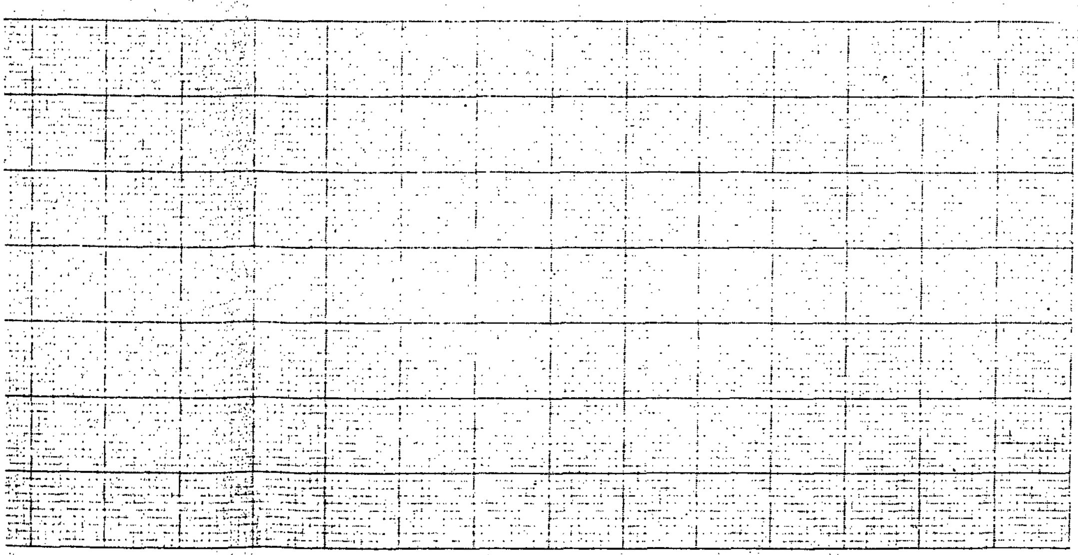
PLATE 2


SILVER LAKE
WEST SILVER LAKE DRIVE
12 TH ST NE
CITY PARK
84-89M
83P
82P
81P
8P
7P
6P
CONCRETE SHORELINE PROTECTION MATTING
SAN. SEWER
15" R.C.P.
PLAN
50 0 50 100
SCALE IN FEET



PLAN

50 0 50 100
SCALE IN FEET



PERM.

TEMP

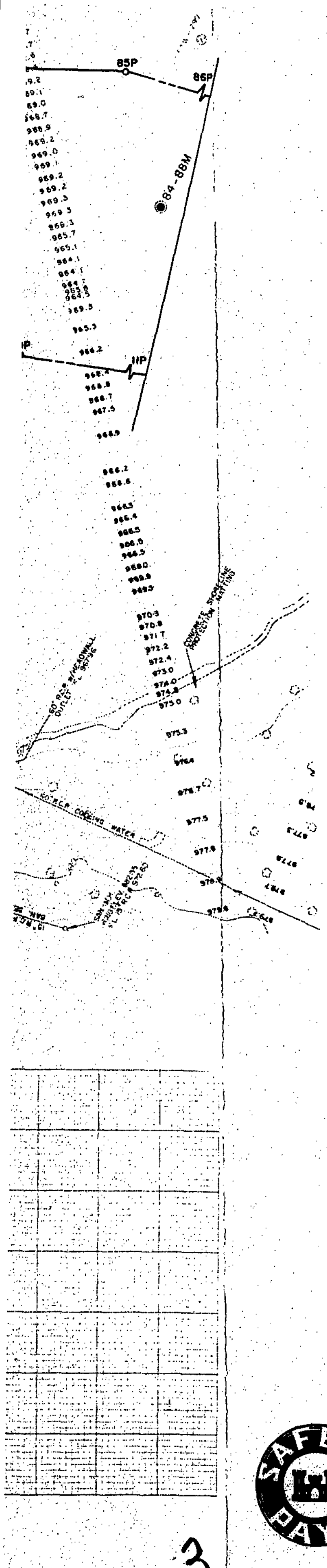
11P INDICATES THAT TH
(11P) IS SHOWN ON

SYMBOL	DESCRIPTIO

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DESIGNED BY: R.G.E	DESIGN MEMORANDU FLOOD CON RC
DRAWN BY: K.R.R.	
CHECKED BY: R.G.E	
SUBMITTED BY:	STA
	APPROVED BY:

2



PERMANENT RIGHT-OF-WAY

TEMPORARY RIGHT-OF-WAY

11P INDICATES THAT THE NEXT RIGHT-OF-WAY POINT (11P) IS SHOWN ON ANOTHER DRAWING

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.G.E

DRAWN BY: K.R.R.

CHECKED BY: R.G.E

SUBMITTED BY:

APPROVED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
RIGHT-OF-WAY
STA. 136+00 TO STA. 148+00

DATE: DECEMBER 1986

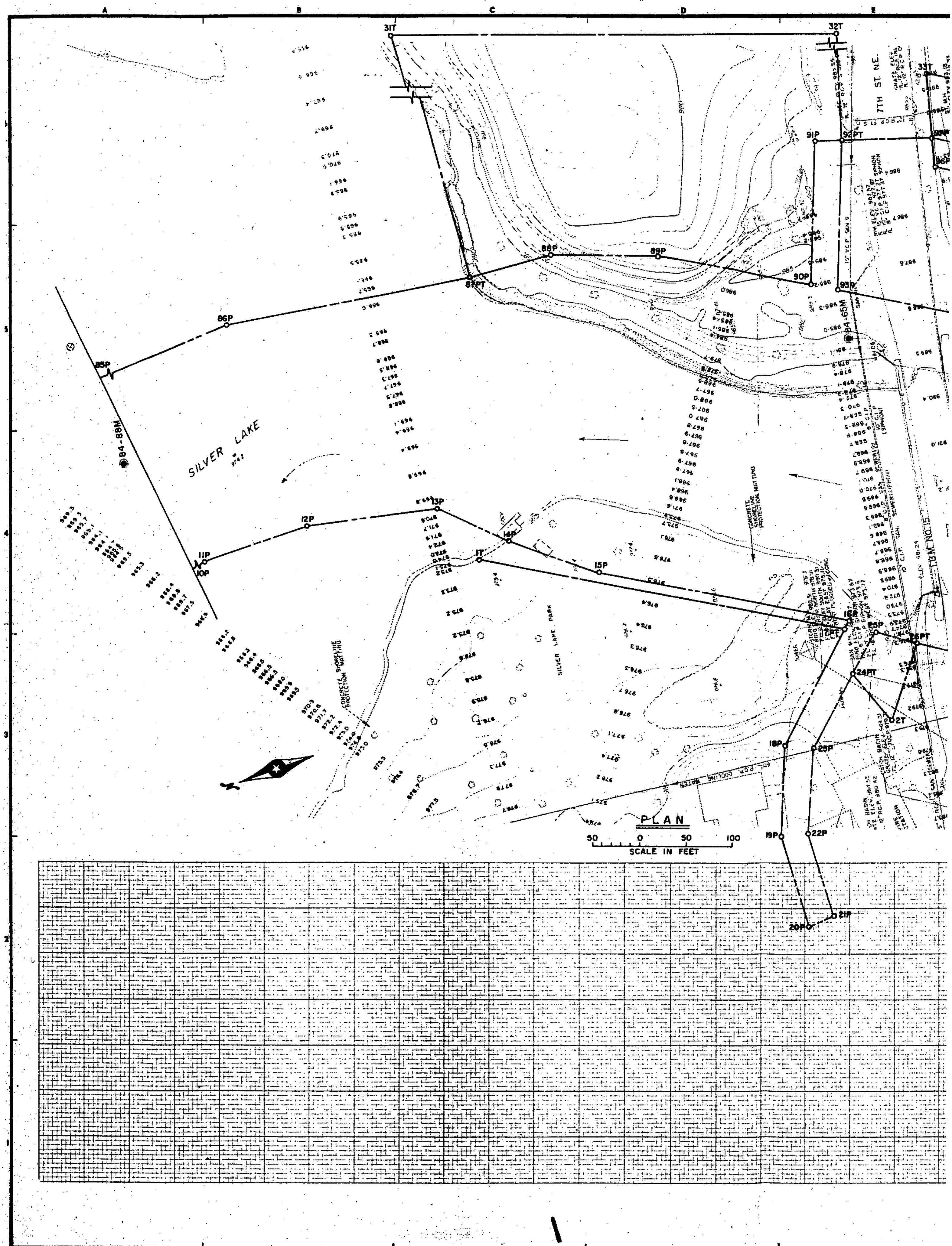
SCALE: AS SHOWN

DRAWING NUMBER: M30-R-11/2

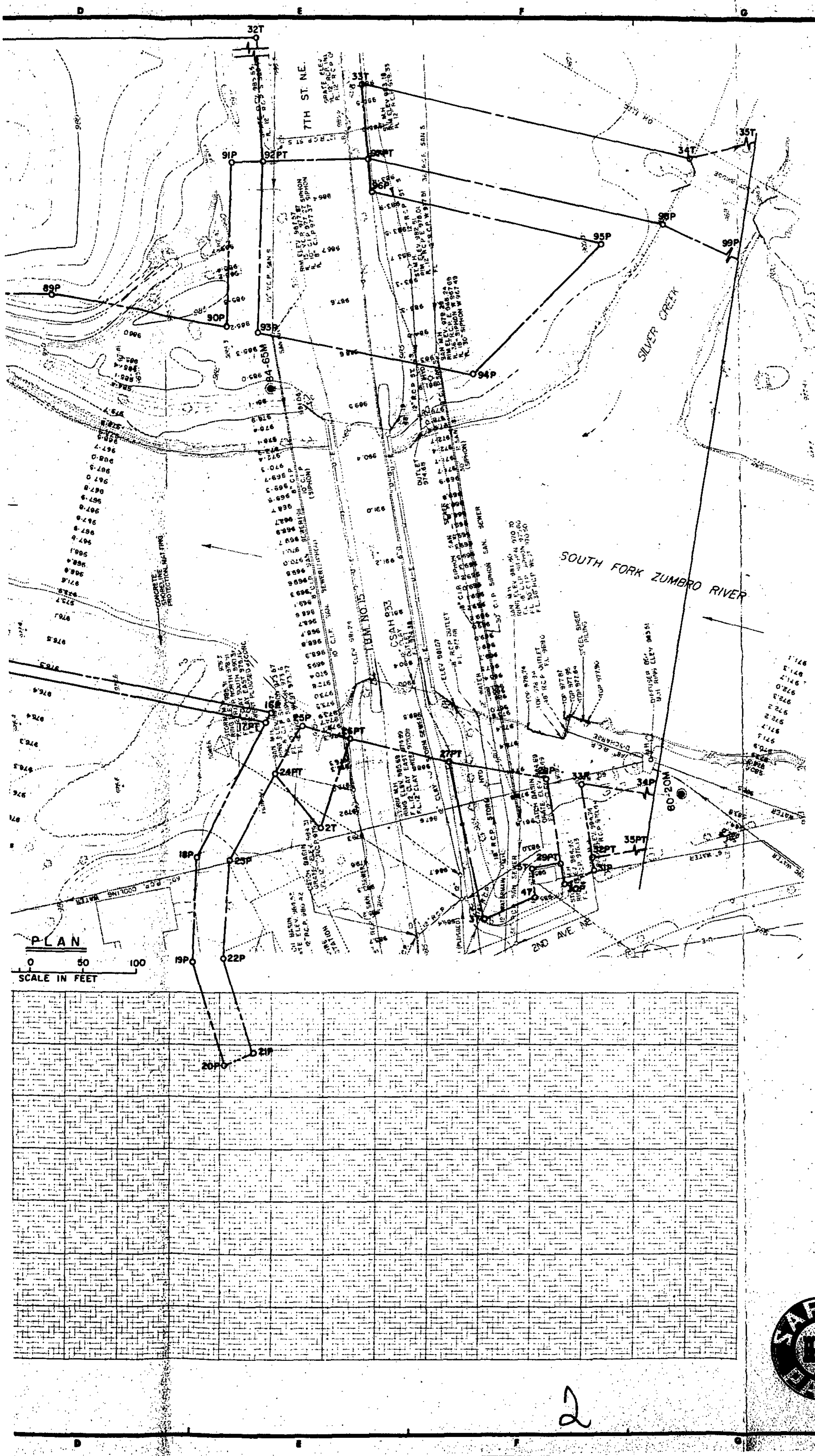
SHEET 3 OF 45

3

PLATE 3



PLAN
50 0 50 100
SCALE IN FEET
SILVER LAKE
SILVER LAKE PARK
7TH ST. NE.
CONCRETE SHORELINE PROTECTION MATTING
T.B.M. NO. 15
B4-88M
B4-65M
31T
32T
33T
85P
86P
87PT
88P
89P
90P
91P
92PT
93P
10P
11P
12P
13P
14P
15P
16P
17PT
18P
19P
20P
21P
22P
23P
24PT
25P
2T
FIRE STATION



PERMANE[NT]

TEMPORA[RY]

34P INDICATES THAT THE N[...] (34P) IS SHOWN ON ANO[THER ...]

SYMBOL	DESCRIPTION

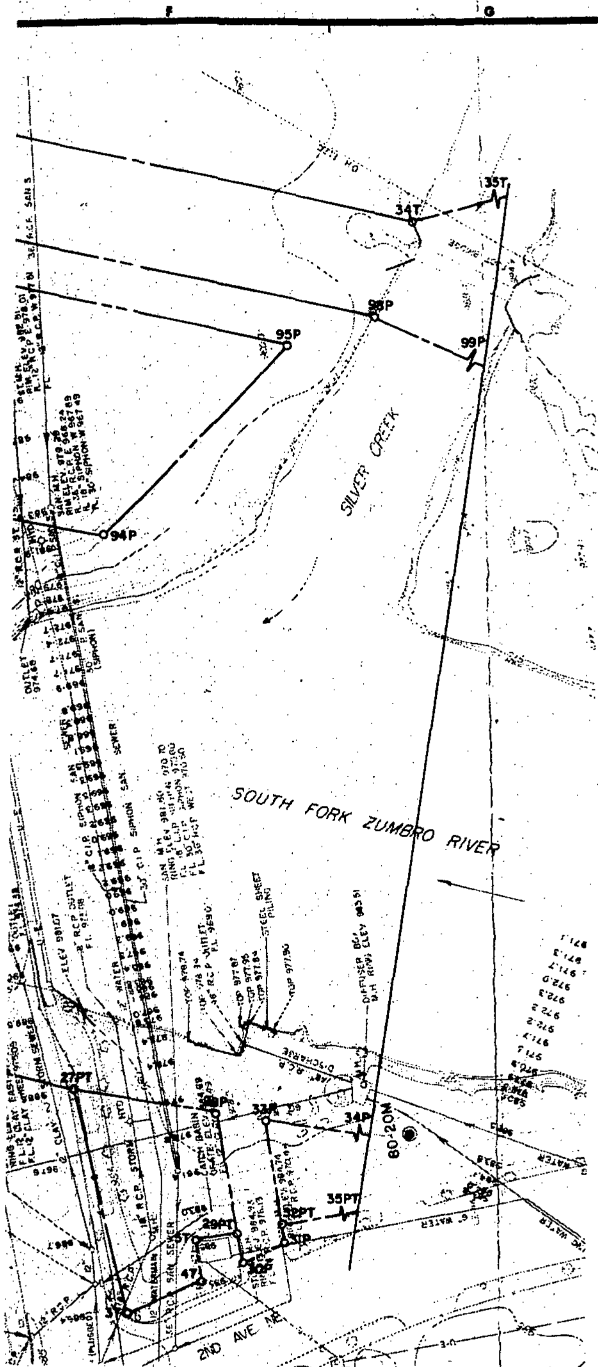
WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E.
SUBMITTED BY:

DESIGN MEMORANDUM
FLOOD CONTRO[L]
ROCHE[STER]
RI[VER]
STA. 14[...]

APPROVED BY:

SAFETY PAYS



PERMANENT RIGHT-OF-WAY

TEMPORARY RIGHT-OF-WAY

34P INDICATES THAT THE NEXT RIGHT-OF-WAY POINT (34P) IS SHOWN ON ANOTHER DRAWING

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

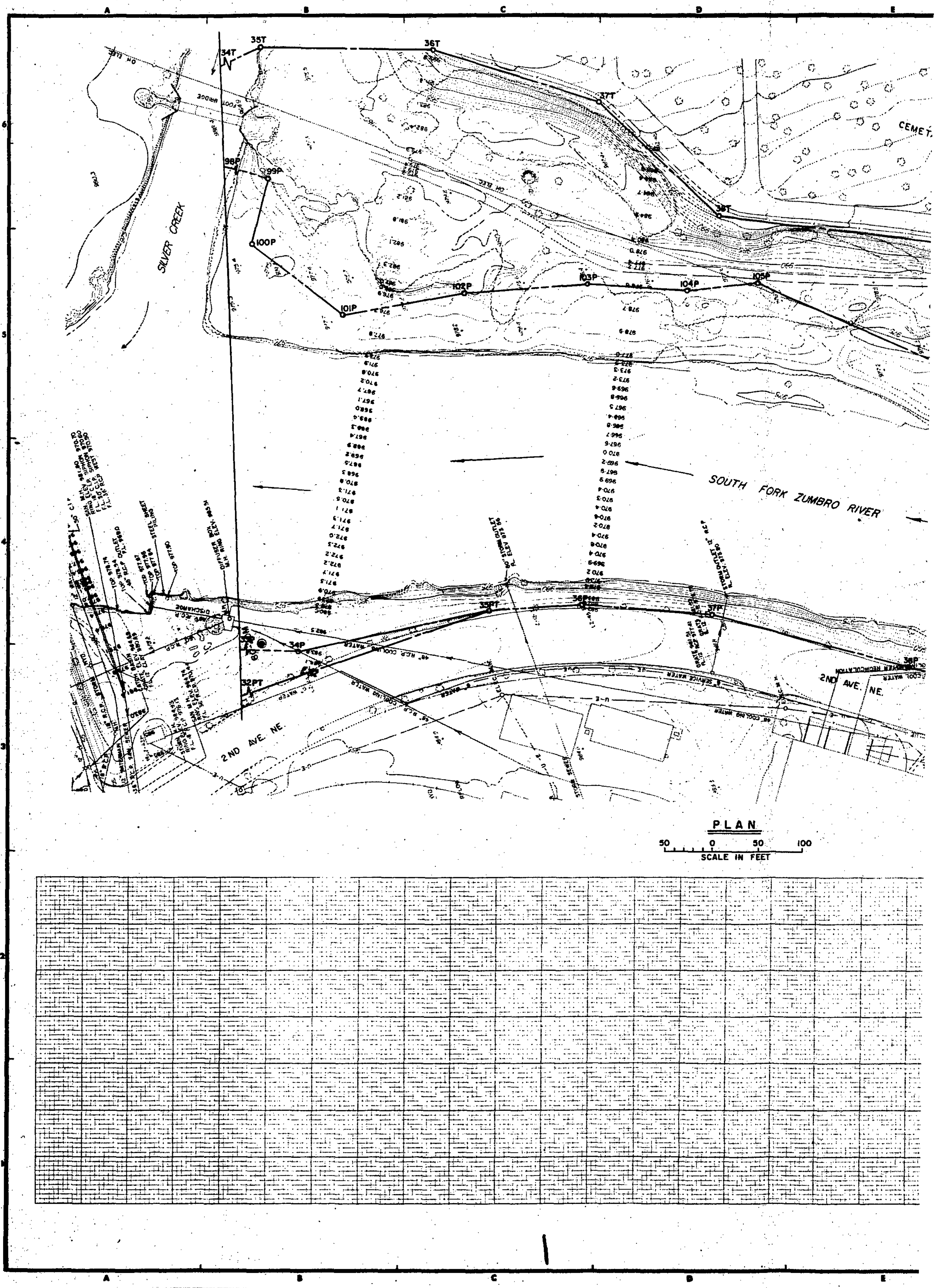
DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
RIGHT-OF-WAY
STA. 148+00 TO STA. 160+00

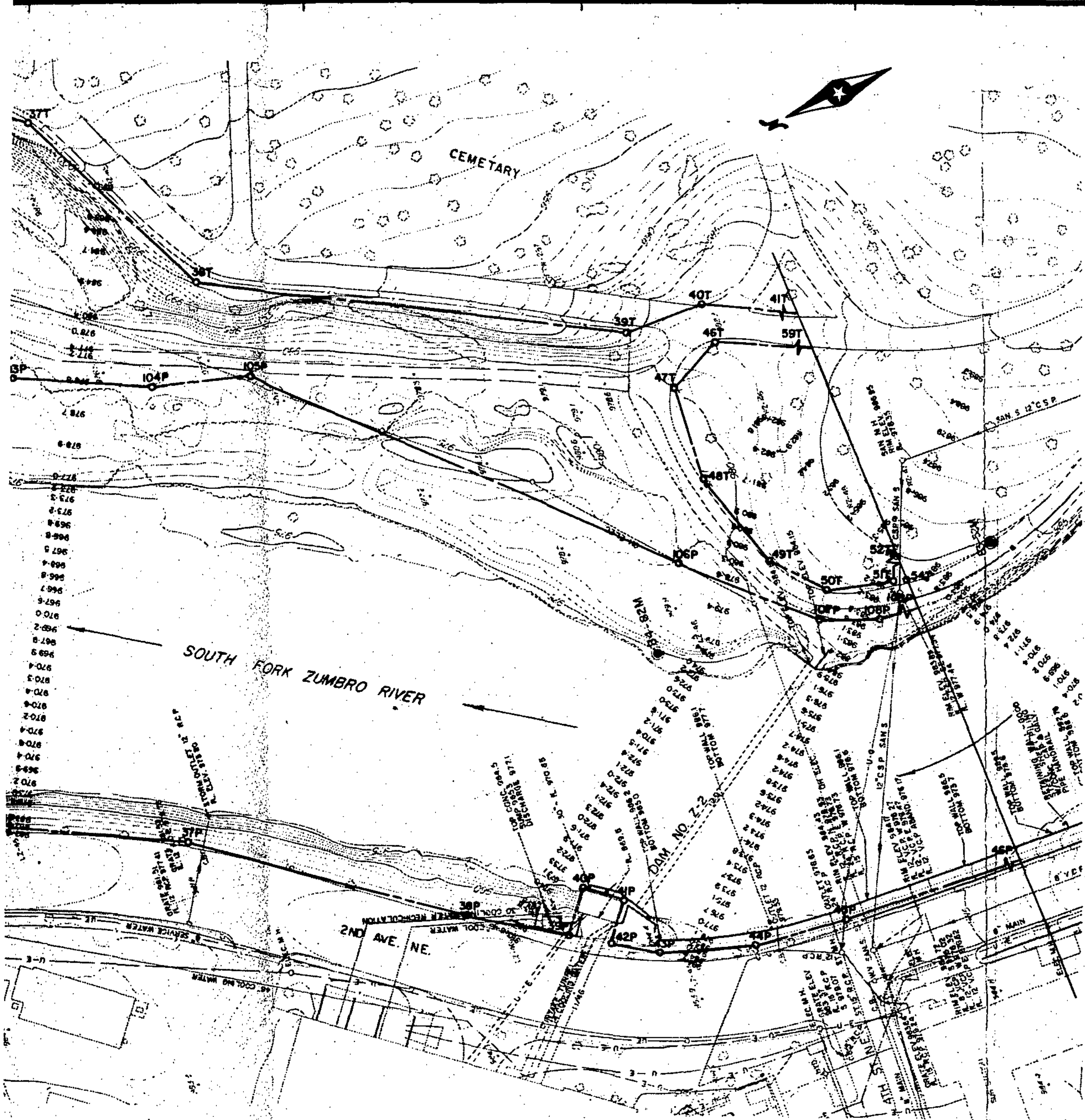
APPROVED BY:
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-11/3
SHEET 4 OF 46

SAFETY PAYS

3


A
B
C
D
E
34T
35T
36T
37T
38T
CEMET.
SILVER CREEK
98P
99P
100P
101P
102P
103P
104P
105P
SOUTH FORK ZUMBRO RIVER
STEEL SHEET PILING
DISCHARGE
32PT
33PT
34P
35PT
36PT
37P
38P
2ND AVE. NE.
STORM SEWER
PLAN
50
0
50
100
SCALE IN FEET

D E F G H



PLAN

50 0 50 100
SCALE IN FEET

46P INDICATES
(46P) IS S

SYMBOL	

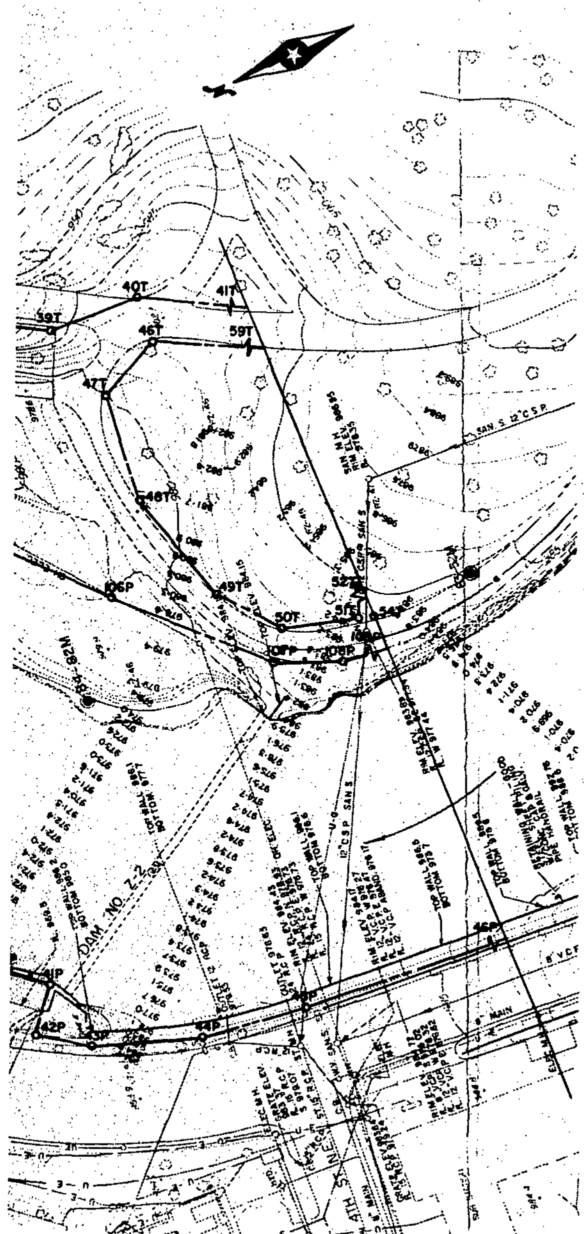
WHKS – Professional Engineers &
Mason City, Ia.– Rochester, Mn.–Du

DESIGNED BY: R.G.E.	DESIGN
DRAWN BY: K.R.R.	
CHECKED BY: R.G.E.	
SUBMITTED BY:	APPROVE

SAFETY PAYS

2

D E F G



PERMANENT RIGHT-OF-WAY

TEMPORARY RIGHT-OF-WAY

46P — INDICATES THAT THE NEXT RIGHT-OF-WAY POINT (46P) IS SHOWN ON ANOTHER DRAWING

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

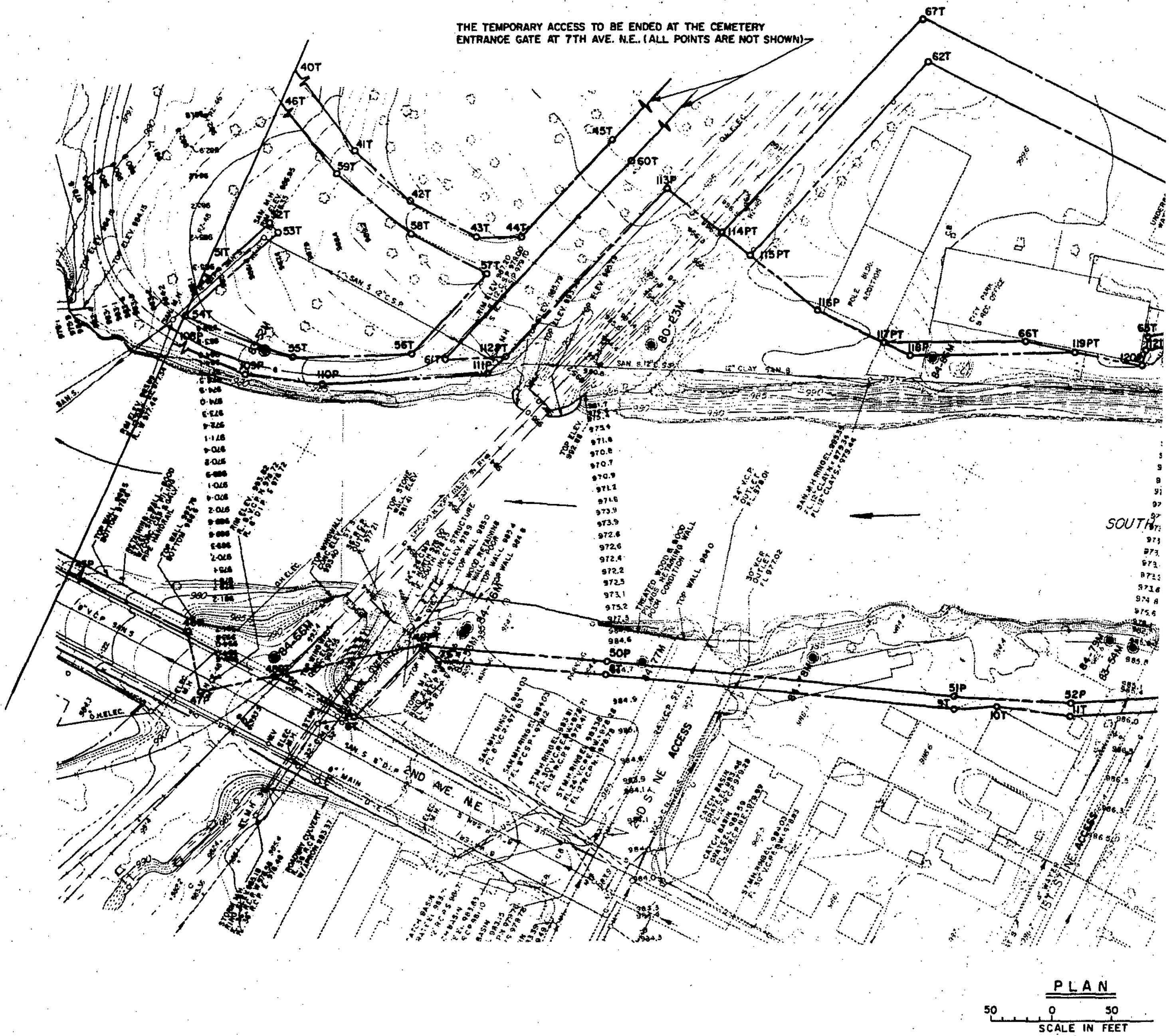
DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E.
SUBMITTED BY:
APPROVED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
RIGHT-OF-WAY
STA. 160+00 TO STA. 171+50

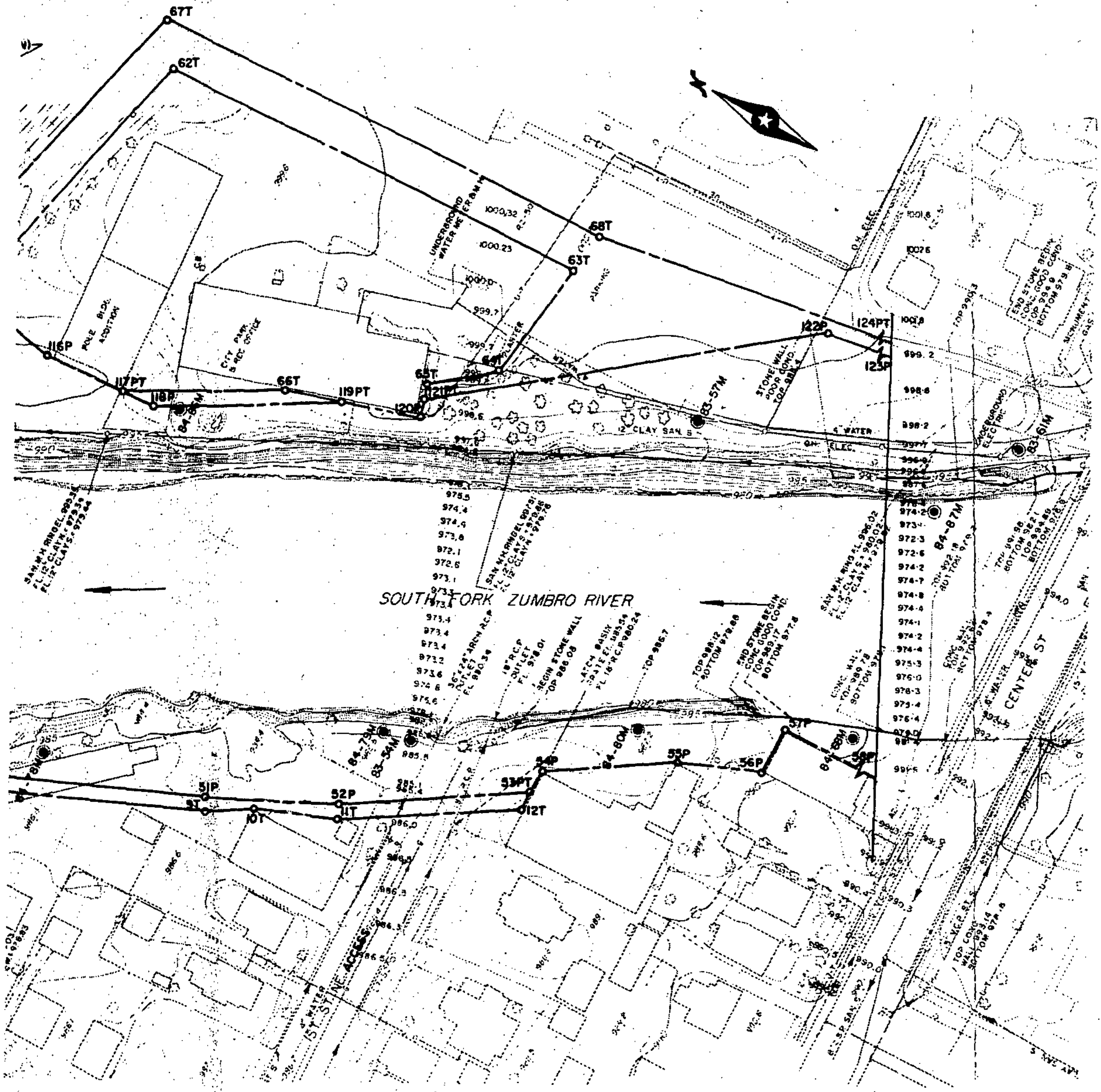
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-11/4
SHEET 5 OF 46

SAFETY PAYS

3



THE TEMPORARY ACCESS TO BE ENDED AT THE CEMETERY
ENTRANCE GATE AT 7TH AVE. N.E. (ALL POINTS ARE NOT SHOWN)
2ND AVE. N.E.
2ND ST NE ACCESS
1ST ST NE ACCESS
SOUTH
PLAN
50 0 50
SCALE IN FEET



PLAN

50 0 50 100
SCALE IN FEET

PERM

TEMI

58P INDICATES THAT T
(58P) IS SHOWN ON

SYMBOL	DESCRIPT

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DESIGNED BY: R.G.E

DESIGN MEMORAN
FLOOD C

DRAWN BY: K.R.R.

CHECKED BY: R.G.E

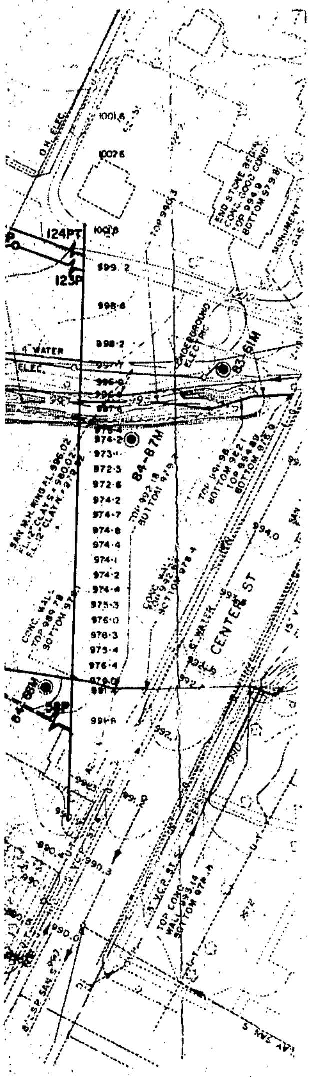
SUBMITTED BY:

APPROVED BY:

S

SAFETY PAYS

2



PERMANENT RIGHT-OF-WAY

TEMPORARY RIGHT-OF-WAY

58P INDICATES THAT THE NEXT RIGHT-OF-WAY POINT (58P) IS SHOWN ON ANOTHER DRAWING

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.G.E
DRAWN BY: K.R.R.
CHECKED BY: R.G.E
SUBMITTED BY:
CHIEF ED-D BRANCH
CHIEF BRANCH

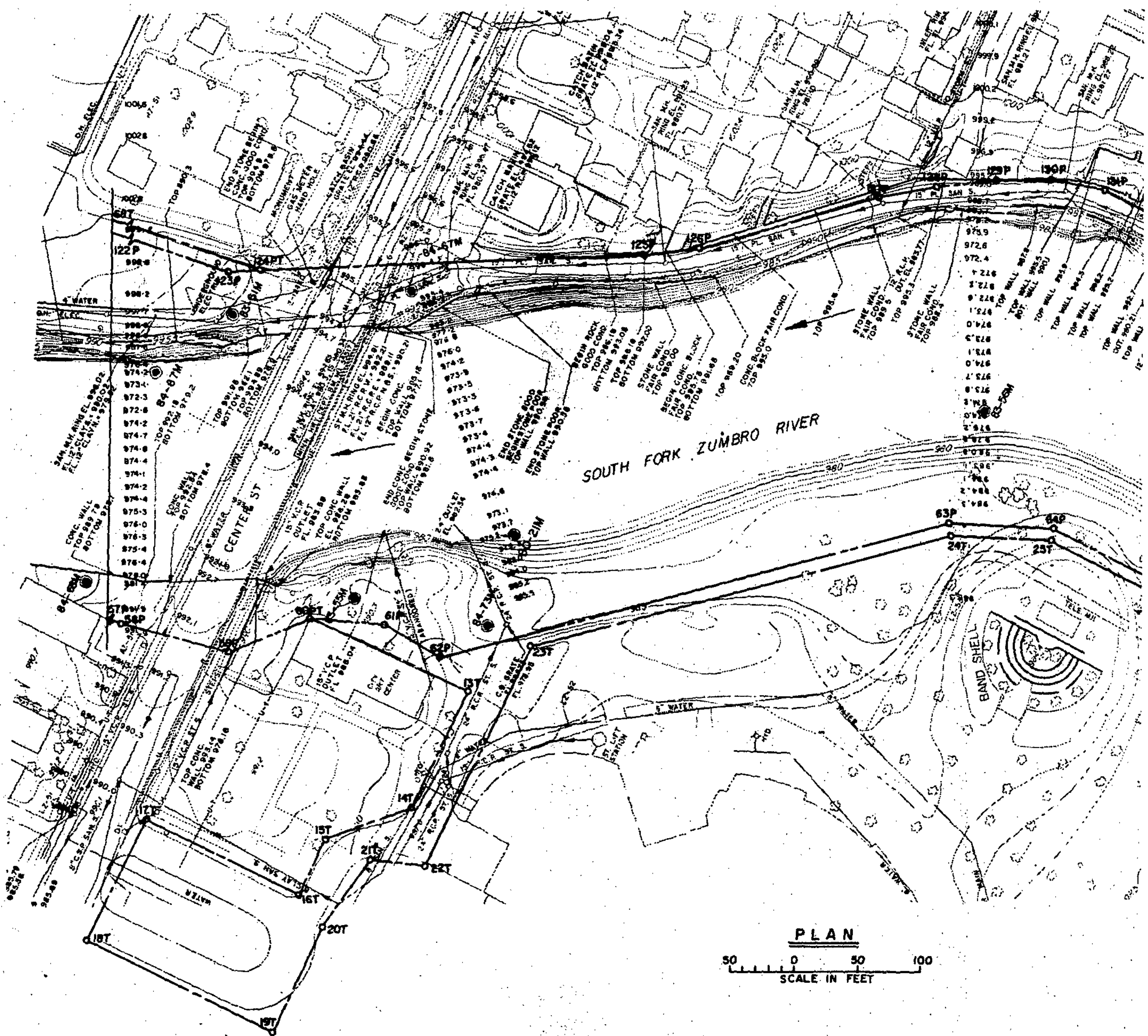
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
RIGHT-OF-WAY
STA. 171+50 TO STA. 183+50

APPROVED BY:
CHIEF ENGR. DIVISION

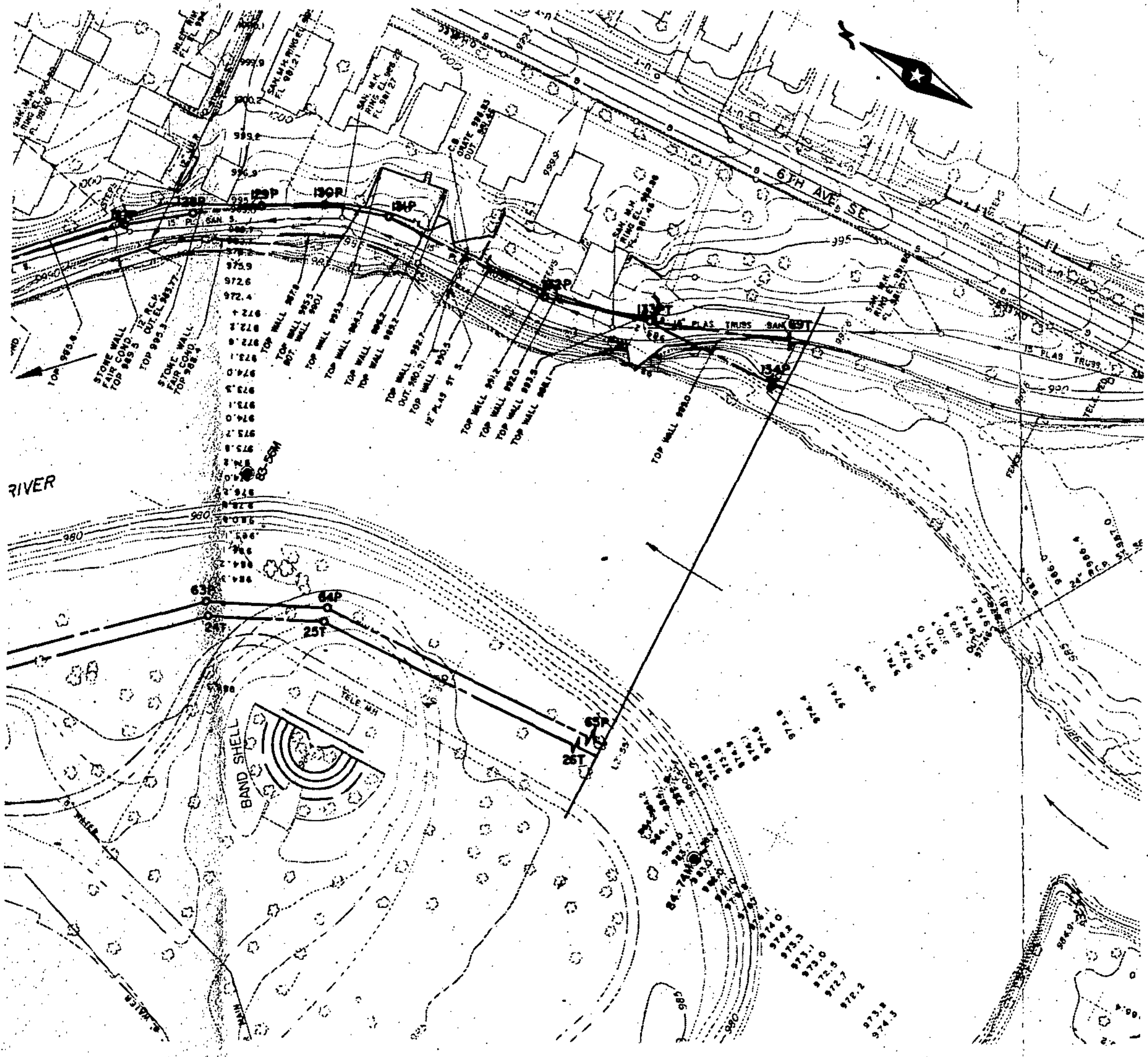
DATE: DECEMBER 1986
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER: M30-R-11/5
SHEET 6 OF 48

3

PLATE 6


SOUTH FORK ZUMBRO RIVER
CENTER ST
BAND SHELL
PLAN
50 0 50 100
SCALE IN FEET

D E F G H



PLAN

0 50 100
SCALE IN FEET

———— — — ———— PERMA
———— — ———— TEMPO

65P INDICATES THAT THI
(65P) IS SHOWN ON A

SYMBOL	DESCRIPTIO

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E.
SUBMITTED BY:
APPROVED BY:

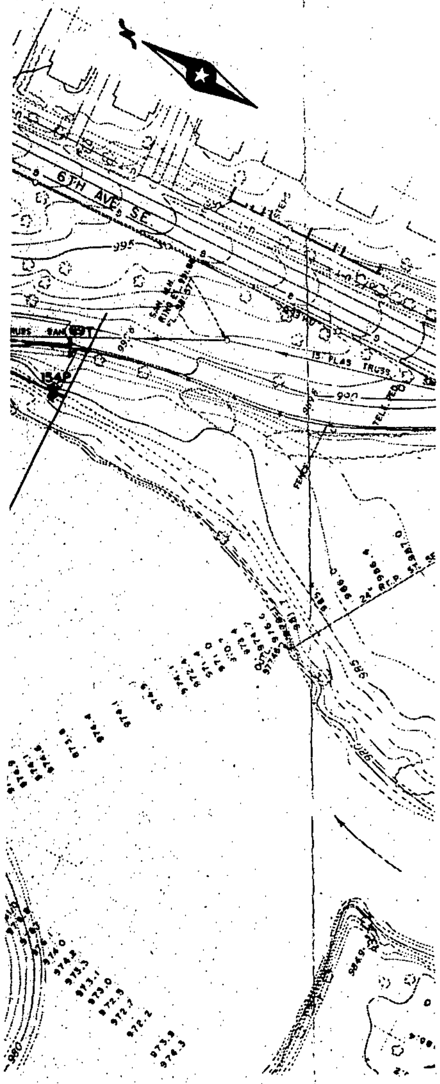
DESIGN MEMORANDU
FLOOD CON
RC
STA

SAFETY PAYS

2

D E F G

G H J



PERMANENT RIGHT-OF-WAY

TEMPORARY RIGHT-OF-WAY

65P INDICATES THAT THE NEXT RIGHT-OF-WAY POINT (65P) IS SHOWN ON ANOTHER DRAWING

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
RIGHT-OF-WAY
STA. 183+50 TO STA. 194+00

APPROVED BY:

DATE: DECEMBER 1986

SCALE: AS SHOWN

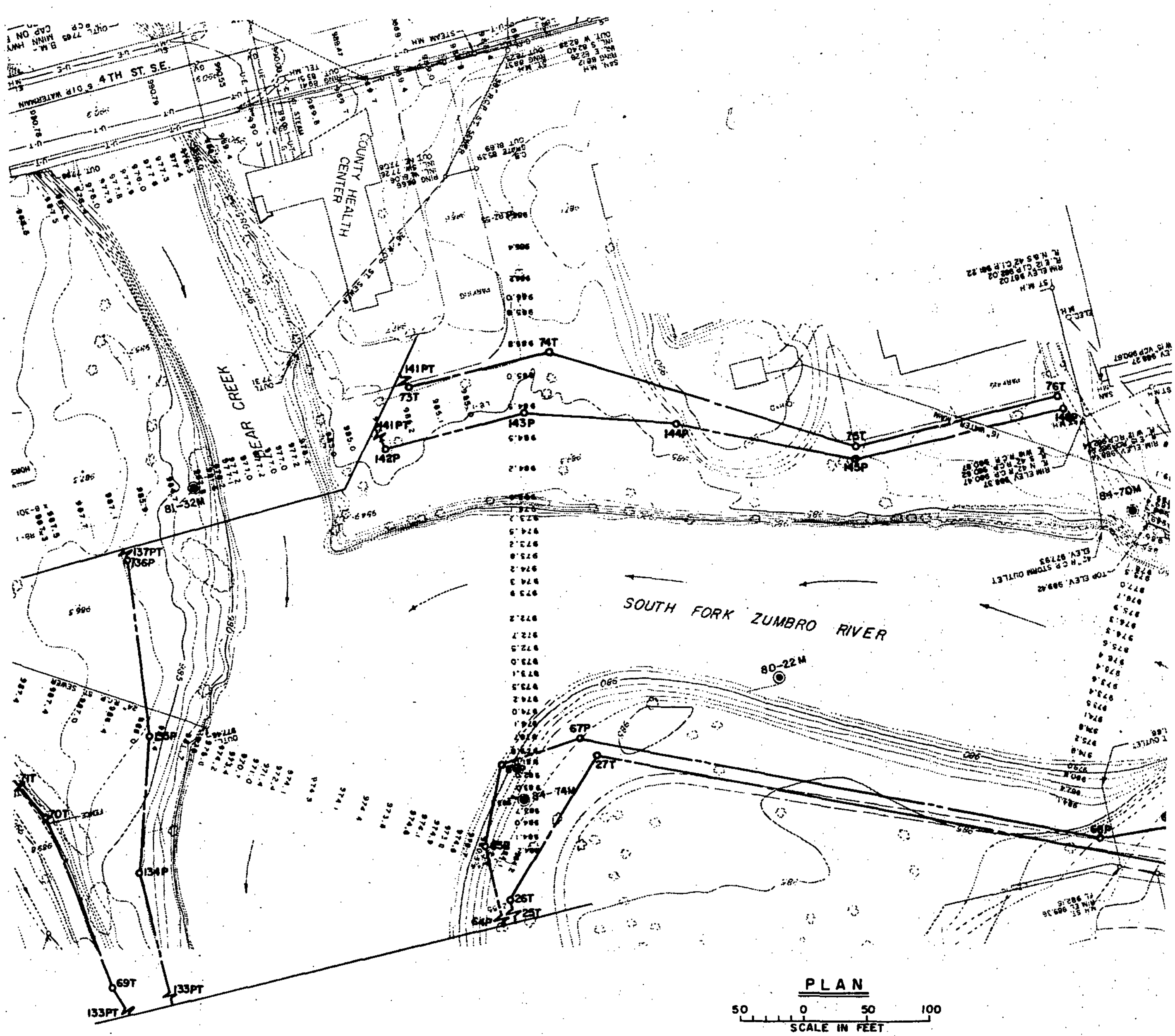
DRAWING NUMBER: M30-R-11/6

SHEET 7 OF 45

3

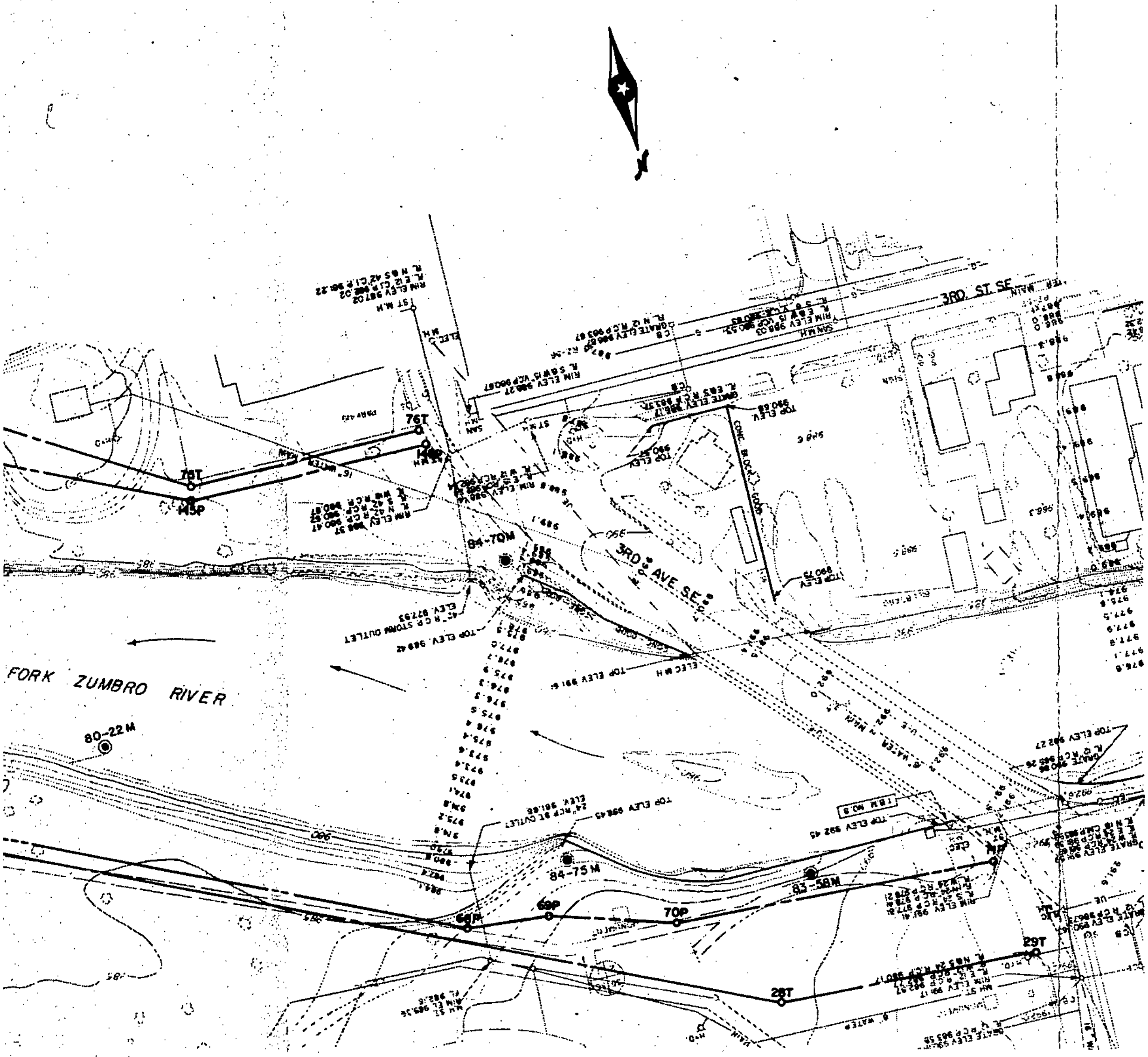
F G

PLATE 7


4TH ST. S.E.
COUNTY HEALTH CENTER
BEAR CREEK
SOUTH FORK ZUMBRO RIVER
74T
141PT
73T
143P
142P
144P
75T
145P
76T
81-32M
84-70M
137PT
136P
80-22M
67P
27T
84-74M
134P
26T
25T
68P
69T
133PT
133PT
SCALE IN FEET
50
0
50
100

PLAN

D E F G H



PLAN

50 0 50 100
SCALE IN FEET

137PT INDICATES TH
(137PT) IS SHOW

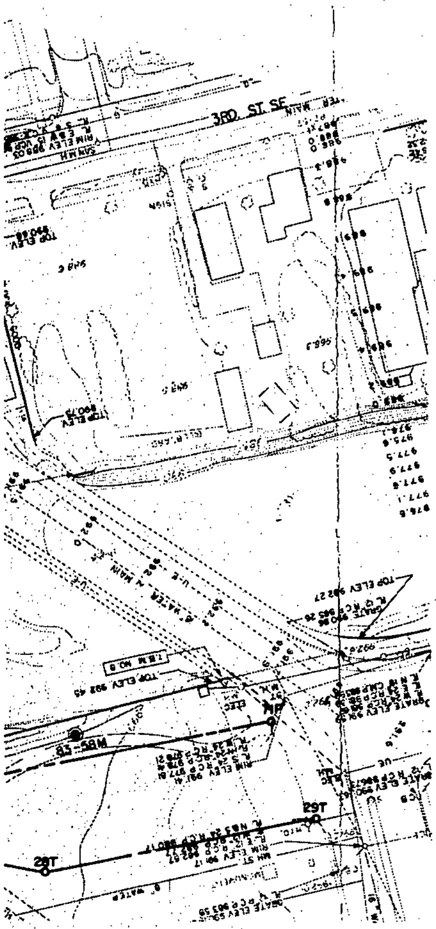
SYMBOL	

WHKS – Professional Engineers & Plan
Mason City, Ia.– Rochester, Mn.–Dubuqu

DESIGNED BY: R.G.E.	DESIGN MEM FLO
DRAWN BY: K.R.R.	
CHECKED BY: R.G.E.	
SUBMITTED BY:	APPROVED B

2

D E F G



PERMANENT RIGHT-OF-WAY

TEMPORARY RIGHT-OF-WAY

137PT — INDICATES THAT THE NEXT RIGHT-OF-WAY POINT (137PT) IS SHOWN ON ANOTHER DRAWING

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

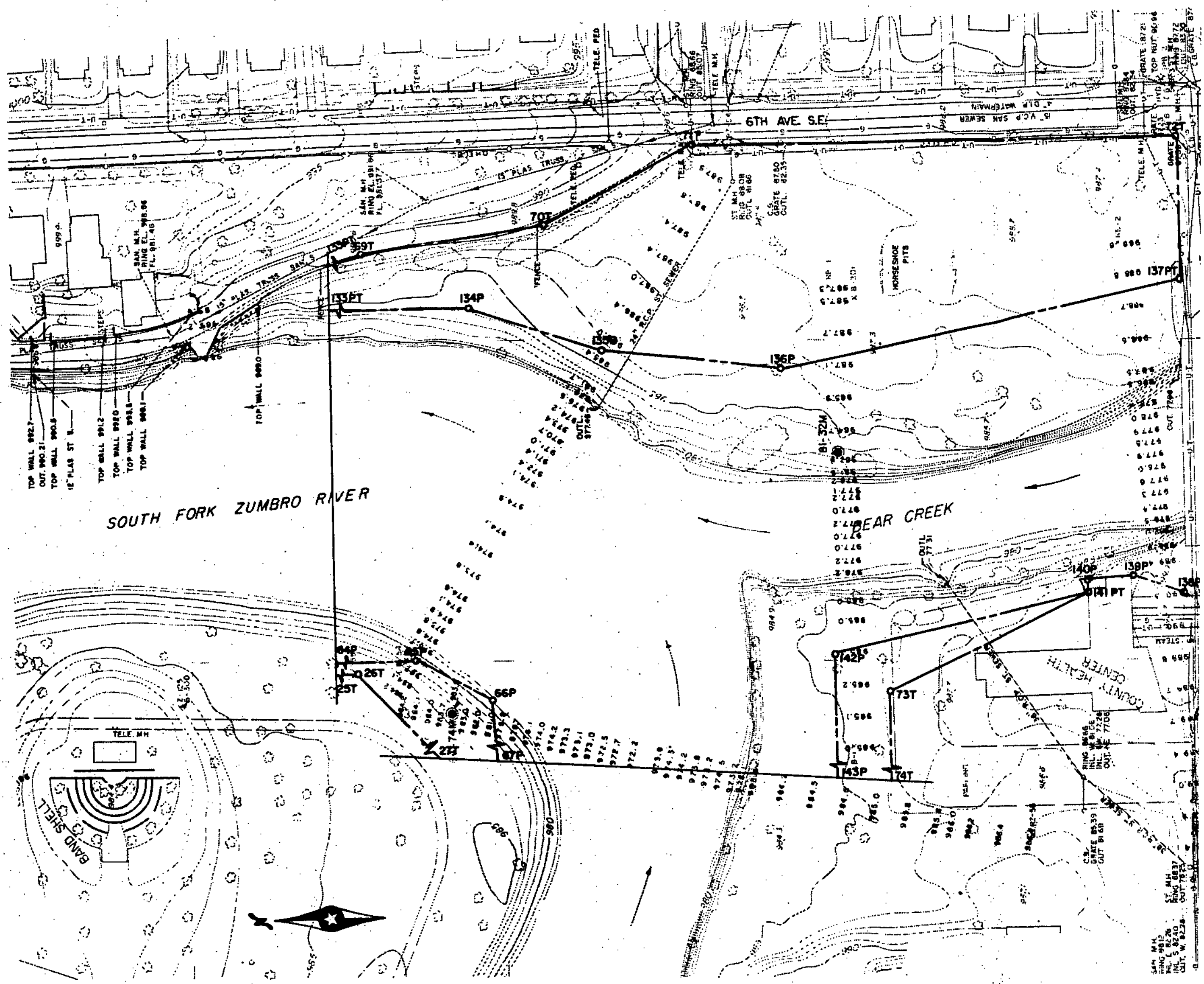
DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E
SUBMITTED BY:
APPROVED BY:

DESIGN MEMORANDUM NO. 2 — FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B.
RIGHT-OF-WAY
STA. 194+00 TO STA. 205+67

DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-11/7
SHEET 8 OF 45

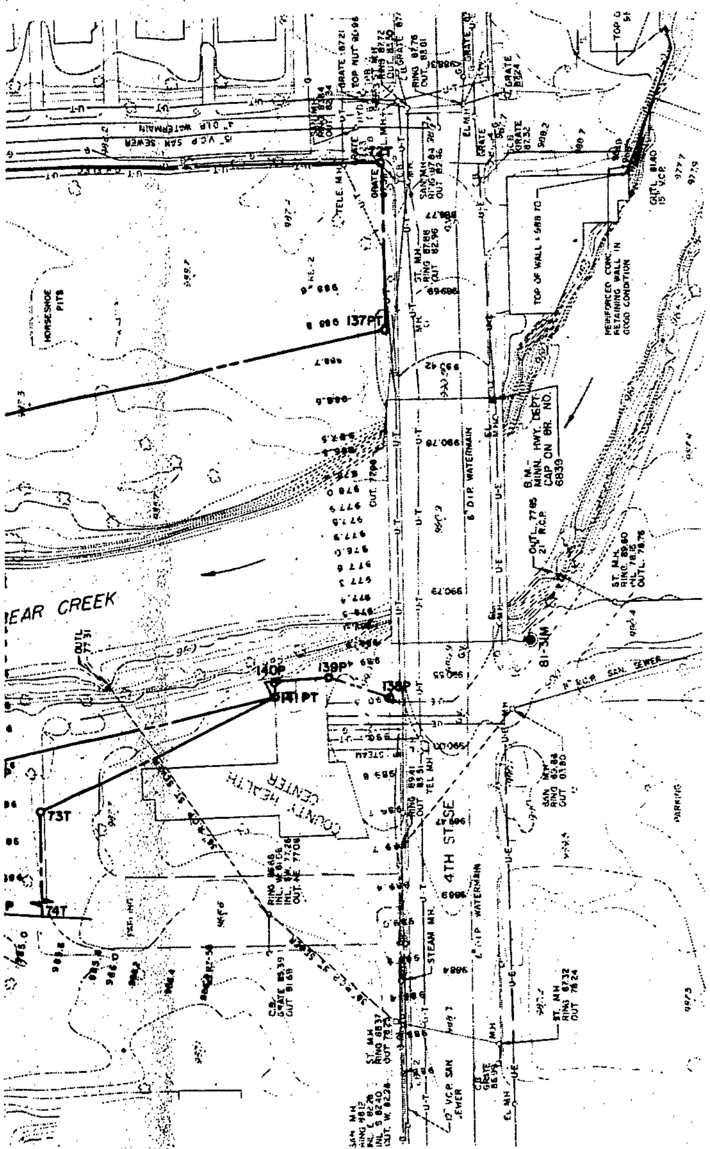
3

SAFETY PAYS



PLAN

50 0 50 100
SCALE IN FEET



100

PERMANENT RIGHT

TEMPORARY RIGHT

64P INDICATES THAT THE NEXT RIGHT (64P) IS SHOWN ON ANOTHER DRAWI

SYMBOL	DESCRIPTION

WHKS - Professional Engineers & Planners Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DEPART

DESIGNED BY: R.G.E.

DRAWN BY: K.R.R

CHECKED BY: R.G.E.

SUBMITTED BY:

APPROVED BY:

DESIGN MEMORANDUM NO. 2
FLOOD CONTROL SOUTH FO
ROCHESTER, MI
STAGE
RIGHT-OF-
STA. 0+00 TO

SCALE AS S

SHEET 9

2

PERMANENT RIGHT-OF-WAY

TEMPORARY RIGHT-OF-WAY

64P — INDICATES THAT THE NEXT RIGHT-OF-WAY POINT (64P) IS SHOWN ON ANOTHER DRAWING

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.G.E.
DRAWN BY: K.R.R
CHECKED BY: R.G.E.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
RIGHT-OF-WAY
STA. 0+00 TO STA. 6+55

APPROVED BY:

DATE: DECEMBER 1986

SCALE: AS SHOWN
SPEC. NO. -

DRAWING NUMBER
M30-R-11/8
SHEET 9 OF 46

3

PLATE 9

A B C D E

RIGHT-OF-WAY
DATA SET 1 PERMANENT ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	1P	381774.000	2404297.000	45.607	S15	15	18W
	2P	381730.000	2404285.000	237.211	S02	24	58W
	3P	381493.000	2404275.000	71.113	S64	09	20E
	4P	381462.000	2404339.000	63.702	N47	32	41E
	5P	381505.000	2404386.000	116.043	N47	05	43E
	6P	381584.000	2404471.000	1116.098	S50	09	42E
	7P	380869.000	2405328.000	164.073	S45	59	16E
	8P	380755.000	2405446.000	320.203	S36	37	10E
	9P	380498.000	2405637.000	123.167	S29	41	14E
	10P	380391.000	2405698.000	118.596	S19	11	56E
	11P	380279.000	2405737.000	120.839	S10	00	29E
	12P	380160.000	2405758.000	146.055	S01	34	10W
	13P	380014.000	2405754.000	84.906	S32	00	19W
	14P	379942.000	2405709.000	106.066	S28	44	23W
	15P	379849.000	2405658.000	282.540	S20	17	42W
	16P	379584.000	2405560.000	10.817	N56	18	36W
	17PT	379590.000	2405551.000	144.201	N52	53	30W
	18P	379677.000	2405436.000	101.000	N78	34	44W
	19P	379697.000	2405337.000	104.235	S81	10	13W
	20P	379681.000	2405234.000	29.120.	S15	56	43E
	21P	379653.000	2405242.000	94.048	N81	26	21E
	22P	379667.000	2405335.000	95.567	S76	41	27E
	23P	379645.000	2405428.000	92.801	S52	52	59E
	24PT	379589.000	2405502.000	52.631	S51	10	13E
	25P	379556.000	2405543.000	47.540	S22	14	57W
	26PT	379512.000	2405525.000	97.693	S22	53	26W
	27PT	379422.000	2405487.000	97.406	S19	10	44W
	28P	379330.000	2405455.000	82.006	S89	18	05W
	29PT	379329.000	2405373.000	20.000	N90	00	00W
	30P	379329.000	2405353.000	31.048	S14	55	53E
	31P	379299.000	2405361.000	14.036	S85	54	52E
	32PT	379298.000	2405375.000	70.000	S90	00	00E
	33P	379298.000	2405445.000	135.680	S19	22	11W
	34P	379170.000	2405400.000	212.476	S06	45	26W
	35PT	378959.000	2405375.000	100.688	S15	33	17W
	36P	378862.000	2405348.000	140.769	S22	33	26W
	37P	378732.000	2405294.000	226.612	S34	23	29W
	38P	378545.000	2405166.000	80.131	S29	07	27W
	39P	378475.000	2405127.000	38.601	S53	25	37E
	40P	378452.000	2405158.000	33.015	S35	08	03W
	41P	378425.000	2405139.000	35.805	N54	05	25W
	42P	378446.000	2405110.000	38.949	S29	11	51W
	43P	378412.000	2405091.000	79.310	S13	51	40W
	44P	378335.000	2405072.000	68.118	S03	21	59W
	45P	378267.000	2405068.000	254.018	S00	40	36E
	46P	378013.000	2405071.000	51.225	S51	20	25W
	47P	377981.000	2405031.000	63.891	S39	55	13E
	48PT	377932.000	2405072.000	129.190	S39	58	33E
	49PT	377833.000	2405155.000	153.114	S23	53	11E
	50P	377693.000	2405217.000	293.615	S22	38	06E
	51P	377422.000	2405330.000	98.412	S25	15	47E
	52P	377333.000	2405372.000	140.132	S31	52	31E
	53PT	377214.000	2405446.000	18.000	S90	00	00E
	54P	377214.000	2405464.000	99.323	S32	15	00E
	55P	377130.000	2405517.000	63.325	S21	17	50E
	56P	377071.000	2405540.000	35.014	N88	21	48E
	57P	377072.000	2405575.000	88.006	S00	39	04E
	58P	376984.000	2405576.000	89.269	S12	56	47E
	59P	376897.000	2405596.000	74.653	S50	58	50E
	60PT	376850.000	2405654.000	58.524	S19	58	59E
	61P	376795.000	2405674.000	52.038	S02	12	09W
	62P	376743.000	2405672.000	423.382	S42	07	41E
	63P	376429.000	2405956.000	87.664	S25	41	17E
	64P	376350.000	2405994.000	277.088	S01	26	51E
	65P	376073.000	2406001.000	68.425	S26	56	22W
	66P	376012.000	2405970.000	67.268	S84	52	58W
	67P	376006.000	2405903.000	431.626	N66	13	34W
	68P	376180.000	2405508.000	58.215	N85	04	22W
	69P	376185.000	2405450.000	92.720	N73	42	54W
	70P	376211.000	2405361.000	231.106	N88	15	52W
	71P	376218.000	2405130.000				

RIGHT-OF-WAY
DATA SET 2 PERMANENT ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	DE
	72P	381967.000	2404341.000	69.260	
	73P	382033.000	2404362.000	154.435	
	74PT	381958.000	2404497.000	46.141	
	75P	381918.000	2404474.000	69.814	
	76P	381875.000	2404529.000	70.434	
	77PT	381820.000	2404573.000	46.400	
	78P	381783.000	2404601.000	94.795	
	79P	381718.000	2404670.000	96.835	
	80P	381662.000	2404749.000	101.519	
	81P	381617.000	2404840.000	893.027	
	82P	381030.000	2405513.000	181.959	
	83P	380895.000	2405635.000	380.623	
	84P	380588.000	2405860.000	180.247	
	85P	380428.000	2405943.000	220.077	
	86P	380213.000	2405990.000	276.116	
	87PT	379937.000	2405998.000	91.548	
	88P	379846.000	2406008.000	118.697	
	89P	379729.000	2405988.000	169.248	
	90P	379570.000	2405930.000	155.913	
	91P	379540.000	2406083.000	29.155	
	92PT	379511.000	2406080.000	162.788	
	93P	379541.000	2405920.000	211.967	
	94P	379342.000	2405847.000	178.441	
	95P	379197.000	2405951.000	231.398	
	96P	379413.000	2406034.000	32.062	
	97PT	379411.000	2406066.000	294.722	
	98P	379136.000	2405960.000	122.886	
	99P	379035.000	2405890.000	72.402	
	100P	379074.000	2405829.000	122.874	
	101P	379007.000	2405726.000	134.350	
	102P	378874.000	2405707.000	133.664	
	103P	378745.000	2405672.000	107.154	
	104P	378646.000	2405631.000	78.103	
	105P	378570.000	2405613.000	361.764	
	106P	378302.000	2405370.000	117.034	
	107P	378213.000	2405294.000	46.487	
	108P	378169.000	2405279.000	96.255	
	109P	378073.000	2405286.000	64.257	
	110P	378013.000	2405309.000	136.858	
	111P	377896.000	2405380.000	19.313	
	112PT	377889.000	2405398.000	194.641	
	113P	377835.000	2405585.000	57.871	
	114PT	377778.000	2405575.000	29.614	
	115PT	377749.000	2405569.000	73.164	
	116P	377677.000	2405556.000	62.073	
	117PT	377615.000	2405559.000	24.083	
	118P	377591.000	2405561.000	137.928	
	119PT	377471.000	2405629.000	58.822	
	120P	377415.000	2405647.000	12.649	
	121PT	377419.000	2405659.000	299.430	
	122P	377182.000	2405842.000	146.660	
	123P	377037.000	2405864.000	26.077	
	124PT	377015.000	2405878.000	310.337	
	125P	376745.000	2406031.000	45.804	
	126P	376708.000	2406058.000	151.427	
	127P	376597.000	2406161.000	45.804	
	128P	376560.000	2406188.000	50.220	
	129P	376519.000	2406217.000	43.829	
	130P	376480.000	2406237.000	46.174	
	131P	376436.000	2406251.000	119.017	
	132P	376317.000	2406253.000	75.432	
	133PT	376244.000	2406272.000	214.009	
	134P	376030.000	2406274.000	109.768	
	135P	375925.000	2406242.000	141.796	
	136P	375784.000	2406227.000	326.377	
	137PT	375465.000	2406296.000		

A B C D E

RIGHT-OF-WAY DATA SET 2 PERMANENT ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	72P	381967.000	2404341.000	69.260	N17	39	00E
	73P	382033.000	2404362.000	154.435	S60	56	43E
	74PT	381958.000	2404497.000	46.141	S29	53	56W
	75P	381918.000	2404474.000	69.814	S51	58	52E
	76P	381875.000	2404529.000	70.434	S38	39	35E
	77PT	381820.000	2404573.000	46.400	S37	07	01E
	78P	381783.000	2404601.000	94.795	S46	42	35E
	79P	381718.000	2404670.000	96.835	S54	40	07E
	80P	381662.000	2404749.000	101.519	S63	41	15E
	81P	381617.000	2404840.000	893.027	S48	54	17E
	82P	381030.000	2405513.000	181.959	S42	06	15E
	83P	380895.000	2405635.000	380.623	S36	14	16E
	84P	380588.000	2405860.000	180.247	S27	25	05E
	85P	380428.000	2405943.000	220.077	S12	19	52E
	86P	380213.000	2405990.000	276.116	S01	39	37E
	87PT	379937.000	2405998.000	91.548	S06	16	16E
	88P	379846.000	2406008.000	118.697	S09	42	01W
	89P	379729.000	2405988.000	169.248	S20	02	27W
	90P	379570.000	2405930.000	155.913	S78	54	23E
	91P	379540.000	2406083.000	29.155	S05	54	22W
	92PT	379511.000	2406080.000	162.788	N79	22	49W
	93P	379541.000	2405920.000	211.967	S20	08	41W
	94P	379342.000	2405847.000	178.441	S35	38	59E
	95P	379197.000	2405951.000	231.398	N21	01	11E
	96P	379413.000	2406034.000	32.062	S86	25	25E
	97PT	379411.000	2406066.000	294.722	S21	04	46W
	98P	379136.000	2405960.000	122.886	S34	43	29W
	99P	379035.000	2405890.000	72.402	N57	24	27W
	100P	379074.000	2405829.000	122.874	S56	57	24W
	101P	379007.000	2405726.000	134.350	S08	07	48W
	102P	378874.000	2405707.000	133.664	S15	10	48W
	103P	378745.000	2405672.000	107.154	S22	29	47W
	104P	378646.000	2405631.000	78.103	S13	19	28W
	105P	378570.000	2405613.000	361.764	S42	11	57W
	106P	378302.000	2405370.000	117.034	S40	29	42W
	107P	378213.000	2405294.000	46.487	S18	49	29W
	108P	378169.000	2405279.000	96.255	S04	10	14E
	109P	378073.000	2405286.000	64.257	S20	58	25E
	110P	378013.000	2405309.000	136.858	S31	15	03E
	111P	377896.000	2405380.000	19.313	S68	44	58E
	112PT	377889.000	2405398.000	194.641	S73	53	34E
	113P	377835.000	2405585.000	57.871	S09	57	02W
	114PT	377778.000	2405575.000	29.614	S11	41	22W
	115PT	377749.000	2405569.000	73.164	S10	14	05W
	116P	377677.000	2405556.000	62.073	S02	46	13E
	117PT	377615.000	2405559.000	24.083	S04	45	49E
	118P	377591.000	2405561.000	137.928	S29	32	20E
	119PT	377471.000	2405629.000	58.822	S17	49	08E
	120P	377415.000	2405647.000	12.649	N71	33	54E
	121PT	377419.000	2405659.000	299.430	S37	40	25E
	122P	377182.000	2405842.000	146.660	S08	37	39E
	123P	377037.000	2405864.000	26.077	S32	28	16E
	124PT	377015.000	2405878.000	310.337	S29	32	20E
	125P	376745.000	2406031.000	45.804	S36	07	10E
	126P	376708.000	2406058.000	151.427	S42	51	33E
	127P	376597.000	2406161.000	45.804	S36	07	10E
	128P	376560.000	2406188.000	50.220	S35	16	21E
	129P	376519.000	2406217.000	43.829	S27	08	59E
	130P	376480.000	2406237.000	46.174	S17	39	00E
	131P	376436.000	2406251.000	119.017	S00	57	46E
	132P	376317.000	2406253.000	75.432	S14	35	20E
	133PT	376244.000	2406272.000	214.009	S00	32	08E
	134P	376030.000	2406274.000	109.768	S16	56	57W
	135P	375925.000	2406242.000	141.796	S06	04	21W
	136P	375784.000	2406227.000	326.377	S12	12	18E
	137PT	375465.000	2406296.000				

RIGHT-OF-WAY DATA SET 3 PERMANENT ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SE
	138P	375462.000	2406052.000	43.012	N17	35	
	139P	375503.000	2406065.000	37.121	N04	38	
	140P	375540.000	2406062.000	10.000	N90	00	
	141PT	375540.000	2406052.000	207.625	N13	22	
	142P	375742.000	2406004.000	116.000	N90	00	
	143P	375742.000	2405888.000	122.711	N72	27	
	144P	375779.000	2405771.000	149.164	N66	42	
	145P	375838.000	2405634.000	173.003	S89	40	
	146P	375837.000	2405461.000				

LEGEND

P INDICATES POINT IS A PERMANENT RIGHT-OF-WAY POINT.

T INDICATES POINT IS A TEMPORARY RIGHT-OF-WAY POINT.

PT INDICATES POINT IS COMMON TO BOTH TYPES OF RIGHT-OF-W

GENERAL NOTE

1. RIGHT-OF-WAY COORDINATES ARE BASED ON MINNESOTA S PLANE GRID SYSTEM.

SYMBOL | DESCRIPTION

WHKS – Professional Engineers & Planners
Mason City, Ia.– Rochester, Mn.– Dubuque, Ia.

DE
ST. P.

DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E.
SUBMITTED BY:
CHIEF ED-D BRANCH

APPROVED BY:
CHIEF

DESIGN MEMORANDUM NO. 2
FLOOD CONTROL SOUT
ROCHESTER
STAG
RIGHT-
DATA

SCALE: N

SHEET

SAFETY PAYS

2

RIGHT-OF-WAY
DATA SET 3 PERMANENT ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	138P	375462.000	2406052.000				
				43.012	N17	35	33E
	139P	375503.000	2406065.000				
				37.121	N04	38	08W
	140P	375540.000	2406062.000				
				10.000	N90	00	00W
	141PT	375540.000	2406052.000				
				207.625	N13	22	01W
	142P	375742.000	2406004.000				
				116.000	N90	00	00W
	143P	375742.000	2405888.000				
				122.711	N72	27	04W
	144P	375779.000	2405771.000				
				149.164	N66	42	02W
	145P	375838.000	2405634.000				
				173.003	S89	40	08W
	146P	375837.000	2405461.000				

BEARING MINUTES	SECONDS
39	00E
56	43E
53	56W
58	52E
39	35E
07	01E
42	35E
40	07E
41	15E
54	17E
06	15E
14	16E
25	05E
19	52E
39	37E
16	16E
42	01W
02	27W
54	23E
54	22W
22	49W
08	41W
38	59E
01	11E
25	25E
04	46W
43	29W
24	27W
57	24W
07	48W
10	48W
29	47W
19	28W
11	57W
29	42W
49	29W
10	14E
58	25E
15	03E
44	58E
53	34E
57	02W
41	22W
14	05W
46	13E
45	49E
32	20E
49	08E
33	54E
40	25E
37	39E
28	16E
32	20E
07	10E
51	33E
07	10E
16	21E
08	59E
39	00E
57	46E
35	20E
32	08E
56	57W
04	21W
12	18E

LEGEND

P INDICATES POINT IS A PERMANENT RIGHT-OF-WAY POINT.
T INDICATES POINT IS A TEMPORARY RIGHT-OF-WAY POINT.
PT INDICATES POINT IS COMMON TO BOTH TYPES OF RIGHT-OF-WAY.

GENERAL NOTE

1. RIGHT-OF-WAY COORDINATES ARE BASED ON MINNESOTA STATE PLANE GRID SYSTEM.

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
RIGHT-OF-WAY
DATA SETS

APPROVED BY:
DATE: DECEMBER 1986
SCALE: NO SCALE
DRAWING NUMBER: M30-R-11/9
SHEET 10 OF 48

SAFETY PAYS

3

RIGHT-OF-WAY
DATA SET 4 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	1T	379978.000	2405693.000	413.168	S20	06	06W
	17PT	379590.000	2405551.000				

RIGHT-OF-WAY
DATA SET 5 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	24PT	379589.000	2405502.000	66.888	S58	26	55W
	2T	379554.000	2405445.000	90.355	S62	18	02E
	26PT	379512.000	2405525.000				

RIGHT-OF-WAY
DATA SET 6 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	27PT	379422.000	2405487.000	154.467	S85	32	40W
	3T	379410.000	2405333.000	51.662	S14	34	27E
	4T	379360.000	2405346.000	29.017	S88	01	30E
	5T	379359.000	2405375.000	30.067	S03	48	51W
	29PT	379329.000	2405373.000				

RIGHT-OF-WAY
DATA SET 7 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	32PT	379298.000	2405375.000	339.000	S00	00	00W
	35PT	378959.000	2405375.000				

RIGHT-OF-WAY
DATA SET 8 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	48PT	377932.000	2405072.000	79.057	S02	10	29E
	6T	377853.000	2405075.000	82.462	S75	57	50E
	49PT	377833.000	2405155.000	17.464	S23	37	46W
	7T	377817.000	2405148.000	146.414	S23	45	50E
	8T	377683.000	2405207.000	288.087	S23	05	39E
	9T	377418.000	2405320.000	37.736	S32	00	19E
	10T	377386.000	2405340.000	61.098	S21	06	17E
	11T	377329.000	2405362.000	134.629	S31	19	43E
	12T	377214.000	2405432.000	14.000	S90	00	00E
	53PT	377214.000	2405446.000				

RIGHT-OF-WAY
DATA SET 9 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	60PT	376850.000	2405654.000	140.089	S02	02	44E
	13T	376710.000	2405659.000	105.043	S88	21	48W
	14T	376707.000	2405554.000	74.330	N47	43	35W
	15T	376757.000	2405499.000	49.010	S88	49	51W
	16T	376756.000	2405450.000	138.091	N02	04	30W
	17T	376894.000	2405445.000	107.019	S88	55	45W
	18T	376892.000	2405338.000	168.048	S01	21	50E
	19T	376724.000	2405342.000	93.086	N87	32	14E
	20T	376728.000	2405435.000	66.753	S81	23	04E
	21T	376718.000	2405501.000	45.880	S20	24	36E
	22T	376675.000	2405517.000	198.124	N87	58	31E
	23T	376682.000	2405715.000	349.052	S42	05	49E
	24T	376423.000	2405949.000	83.672	S24	43	38E
	25T	376347.000	2405984.000	228.140	S02	00	34E
	26T	376119.000	2405992.000	139.316	S45	52	21W
	27T	376022.000	2405892.000	646.067	N66	10	21W
	28T	376283.000	2405301.000	186.067	N88	27	37W
	29T	376288.000	2405115.000				

RI
DATA SET

NOTES	POINT NO.	N-COORDINATE	E-
	74PT	381958.000	
	30T	381892.000	
	77PT	381820.000	

R
DATA SET

NOTES	POINT NO.	N-COORDINATE	E-
	87PT	379937.000	
	31T	379993.000	
	32T	379470.000	
	92PT	379511.000	

R
DATA SET

NOTES	POINT NO.	N-COORDINATE	E-C
	97PT	379411.000	
	33T	379406.000	
	34T	379101.000	
	35T	378997.000	
	36T	378822.000	
	37T	378669.000	
	38T	378585.000	
	39T	378284.000	
	40T	378221.000	
	41T	378081.000	
	42T	378020.000	
	43T	377956.000	
	44T	377923.000	
	45T	377895.000	

R
DATA SET

NOTES	POINT NO.	N-COORDINATE	E-
	46T	378230.000	
	47T	378263.000	
	48T	378263.000	
	49T	378235.000	
	50T	378200.000	
	51T	378150.000	
	52T	378114.000	
	53T	378106.000	
	54T	378140.000	
	55T	378045.000	
	56T	377959.000	
	57T	377934.000	
	58T	378007.000	
	59T	378065.000	
	46T	378230.000	

R
DATA SET

NOTES	POINT NO.	N-COORDINATE	E
	112PT	377889.000	
	61T	377932.000	
	60T	377873.000	

D E F G H

RIGHT-OF-WAY
DATA SET 10 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	74PT	381958.000	2404497.000	131.727	S59	55	53E
	30T	381892.000	2404611.000	81.413	S27	49	27W
	77PT	381820.000	2404573.000				

RIGHT-OF-WAY
DATA SET 11 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	87PT	379937.000	2405998.000	493.190	N83	28	49E
	31T	379993.000	2406488.000	523.215	S01	38	34W
	32T	379470.000	2406473.000	395.133	N84	02	39W
	92PT	379511.000	2406080.000				

RIGHT-OF-WAY
DATA SET 12 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	97PT	379411.000	2406066.000	69.181	S85	51	19E
	33T	379406.000	2406135.000	327.031	S21	09	03W
	34T	379101.000	2406017.000	104.389	S04	56	46E
	35T	378997.000	2406026.000	185.995	S19	47	56W
	36T	378822.000	2405963.000	189.613	S36	12	18W
	37T	378669.000	2405851.000	178.941	S62	00	10W
	38T	378585.000	2405693.000	333.672	S25	34	00W
	39T	378284.000	2405549.000	63.032	S01	49	06E
	40T	378221.000	2405551.000	153.935	S24	34	02W
	41T	378081.000	2405487.000	62.586	S12	55	34W
	42T	378020.000	2405473.000	64.008	S00	53	43E
	43T	377956.000	2405474.000	37.590	S28	36	38E
	44T	377923.000	2405492.000	109.636	S75	12	12E
	45T	377895.000	2405598.000				

RIGHT-OF-WAY
DATA SET 13 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	46T	378230.000	2405520.000	40.224	N34	52	31W
	47T	378263.000	2405497.000	73.000	N90	00	00W
	48T	378263.000	2405424.000	80.056	S69	31	40W
	49T	378235.000	2405349.000	50.210	S45	48	25W
	50T	378260.000	2405313.000	50.990	S11	18	36W
	51T	378150.000	2405303.000	103.465	S69	38	18E
	52T	378114.000	2405400.000	8.544	S20	33	22W
	53T	378106.000	2405397.000	101.843	N70	29	51W
	54T	378140.000	2405301.000	95.755	S07	11	57E
	55T	378045.000	2405313.000	99.479	S30	10	25E
	56T	377959.000	2405363.000	92.445	S74	18	36E
	57T	377934.000	2405452.000	73.062	N02	21	12W
	58T	378007.000	2405449.000	79.076	N09	27	44E
	59T	378083.000	2405462.000	156.170	N21	48	05E
	46T	378230.000	2405520.000				

RIGHT-OF-WAY
DATA SET 14 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	112PT	377889.000	2405398.000	49.739	N30	10	25 W
	61T	377932.000	2405373.000	224.878	S 74	47	23 E
	60T	377873.000	2405590.000				

RIGHT-OF-WAY
DATA SET 15 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	DEGREES
	114PT	377778.000	2405575.000	240.666	S74
	67T	377714.000	2405807.000	352.363	S02
	68T	377362.000	2405823.000	351.332	S09
	124PT	377015.000	2405878.000		

RIGHT-OF-WAY
DATA SET 16 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	DEGREES
	115 PT	377749.000	2405569.000	216.116	S75
	62T	377694.000	2405778.000	328.258	S02
	63T	377366.000	2405791.000	88.459	N79
	64T	377382.000	2405704.000	52.498	N40
	65T	377422.000	2405670.000	11.402	S74
	121PT	377419.000	2405659.000		

RIGHT-OF-WAY
DATA SET 17 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	DEGREES
	117 PT	377615.000	2405559.000	118.207	S29
	66T	377512.000	2405617.000	42.720	S16
	119PT	377471.000	2405629.000		

RIGHT-OF-WAY
DATA SET 18 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	DEGREES
	133PT	376244.000	2406272.000	136.956	S19
	69T	376115.000	2406318.000	146.513	S08
	70T	375970.000	2406339.000	132.412	S27
	71T	375853.000	2406401.000	385.047	S00
	72T	375468.000	2406407.000	111.041	S88
	137PT	375465.000	2406296.000		

RIGHT-OF-WAY
DATA SET 19 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	DEGREES
	141 PT	375540.000	2406052.000	174.897	N25
	73T	375698.000	2405977.000	120.004	N89
	74T	375699.000	2405857.000	258.490	N60
	75T	375828.000	2405633.000	170.003	S89
	76T	375827.000	2405463.000		

LEGEND

P INDICATES POINT IS A PERMANENT RIGHT-OF-WAY POINT.
T INDICATES POINT IS A TEMPORARY RIGHT-OF-WAY POINT.
PT INDICATES POINT IS COMMON TO BOTH TYPES OF RIGHT-OF-WAY.

GENERAL NOTE

1. RIGHT-OF-WAY COORDINATES ARE BASED ON MINNESOTA STATE PLANE GRID SYSTEM.

SYMBOL

WHKS – Professional Engineers & Planne
Mason City, Io.– Rochester, Mn. – Dubuque,

DESIGNED BY: R.G.E.
DRAWN BY: K.R.R
CHECKED BY: R.G.E.
SUBMITTED BY:

DESIGN MEMO
FLOO

APPROVED BY

2

D E F G

RIGHT-OF-WAY
DATA SET 15 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	114PT	377778.000	2405575.000	240.666	S74	34	40E
	67T	377714.000	2405807.000	352.363	S02	36	09E
	68T	377362.000	2405823.000	351.332	S09	00	24E
	124PT	377015.000	2405878.000				

RIGHT-OF-WAY
DATA SET 16 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	115 PT	377749.000	2405569.000	216.116	S75	15	23E
	62T	377694.000	2405778.000	328.258	S02	16	11E
	63T	377366.000	2405791.000	88.459	N79	34	45W
	64T	377382.000	2405704.000	52.498	N40	21	52W
	65T	377422.000	2405670.000	11.402	S74	44	42W
	121PT	377419.000	2405659.000				

RIGHT-OF-WAY
DATA SET 17 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	117 PT	377615.000	2405559.000	118.207	S29	23	03E
	66T	377512.000	2405617.000	42.720	S16	18	50E
	119PT	377471.000	2405629.000				

RIGHT-OF-WAY
DATA SET 18 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	133PT	376244.000	2406272.000	136.956	S19	37	33E
	69T	376115.000	2406318.000	146.513	S08	14	27E
	70T	375970.000	2406339.000	132.412	S27	55	11E
	71T	375853.000	2406401.000	385.047	S00	53	34E
	72T	375468.000	2406407.000	111.041	S88	27	07W
	137PT	375465.000	2406296.000				

RIGHT-OF-WAY
DATA SET 19 TEMPORARY ROW

NOTES	POINT NO.	N-COORDINATE	E-COORDINATE	DISTANCE	BEARING DEGREES	BEARING MINUTES	BEARING SECONDS
	141 PT	375540.000	2406052.000	174.897	N25	23	35W
	73T	375698.000	2405977.000	120.004	N89	31	21W
	74T	375699.000	2405857.000	258.490	N60	03	46W
	75T	375828.000	2405633.000	170.003	S89	39	47W
	76T	375827.000	2405463.000				

LEGEND

P INDICATES POINT IS A PERMANENT RIGHT-OF-WAY POINT.
T INDICATES POINT IS A TEMPORARY RIGHT-OF-WAY POINT.
PT INDICATES POINT IS COMMON TO BOTH TYPES OF RIGHT-OF-WAY.

GENERAL NOTE

1. RIGHT-OF-WAY COORDINATES ARE BASED ON MINNESOTA STATE PLANE GRID SYSTEM.

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

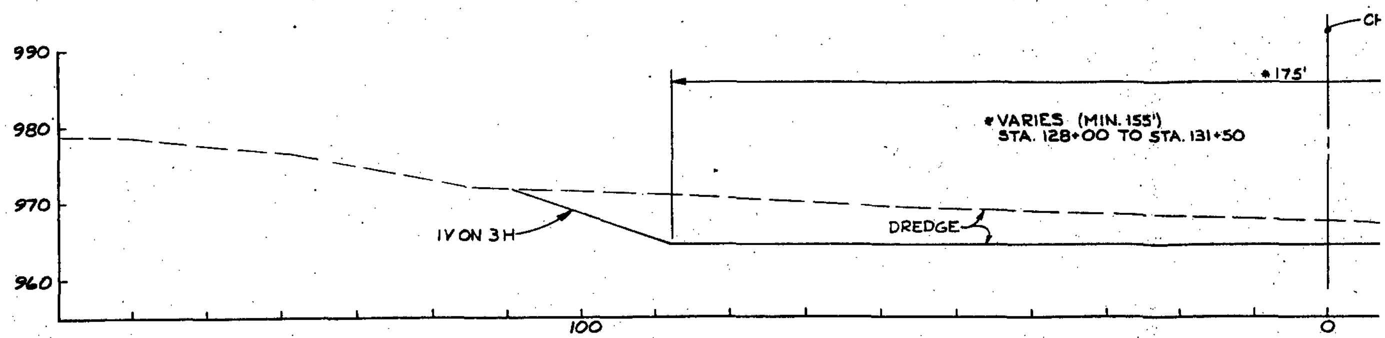
DESIGNED BY: R.G.E.
DRAWN BY: K.R.R.
CHECKED BY: R.G.E.
SUBMITTED BY:
APPROVED BY: Robert L. Voigt

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
RIGHT-OF-WAY
DATA SETS

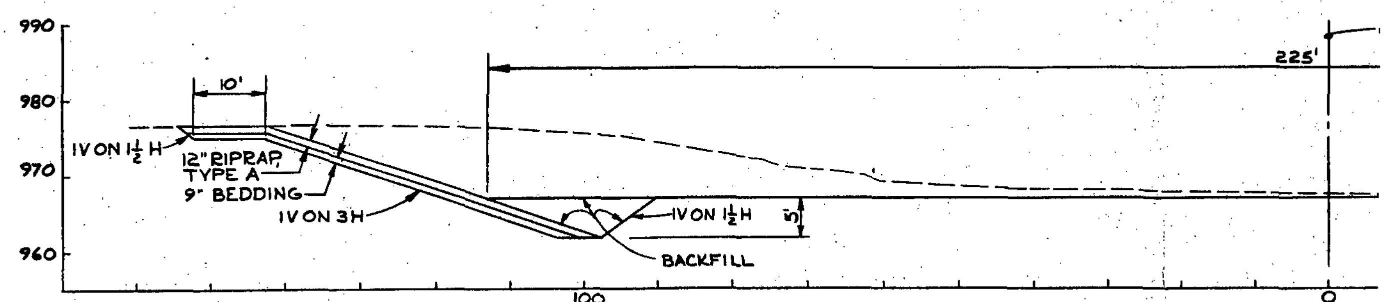
DATE: DECEMBER 1986
SCALE: NO SCALE
DRAWING NUMBER M30-R-11/10
SHEET 11 OF 45

SAFETY DAYS

3



TYPICAL SECTION STA. 12



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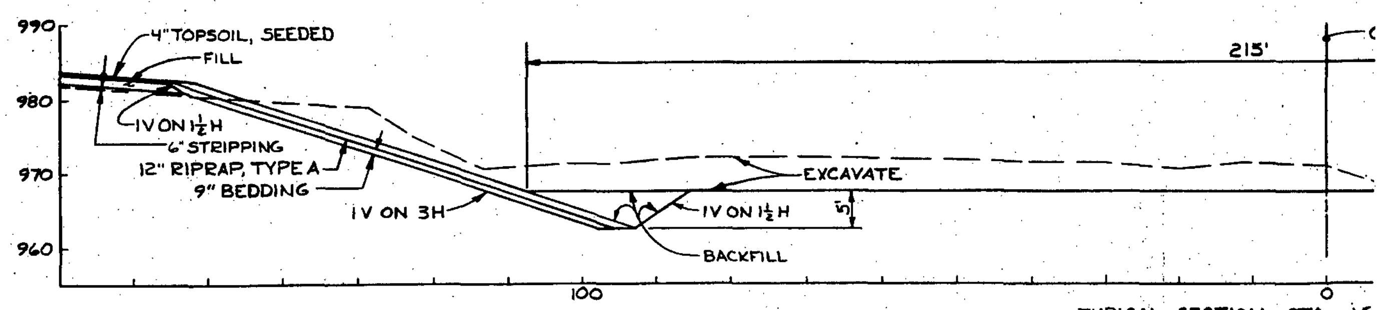
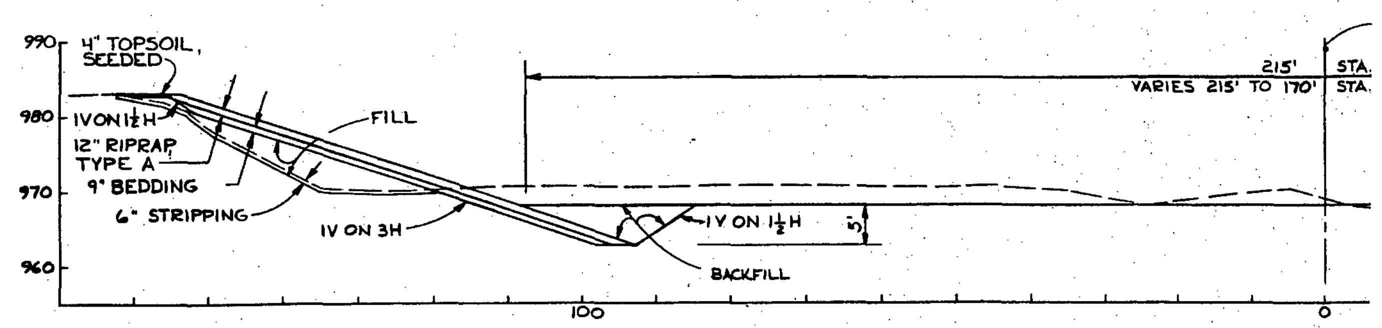


TYPICAL SECTION STA. 15



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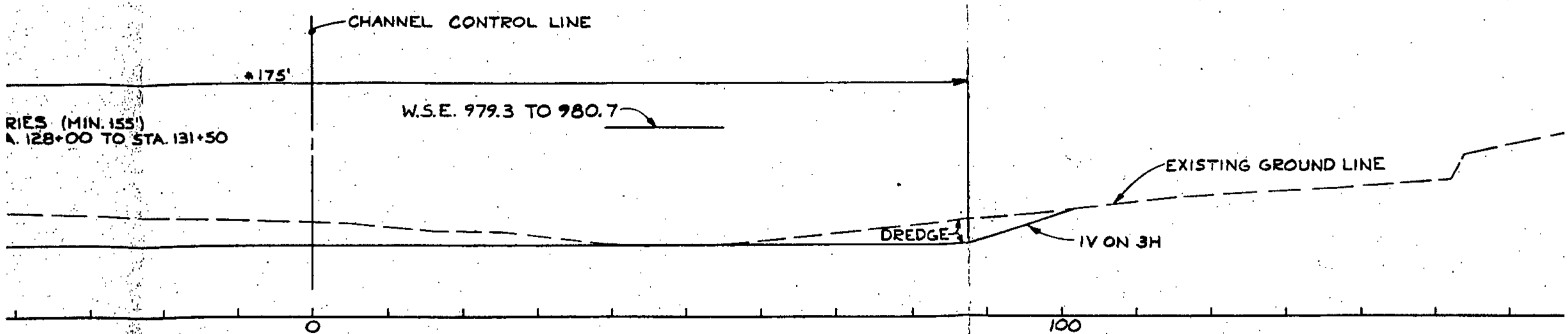
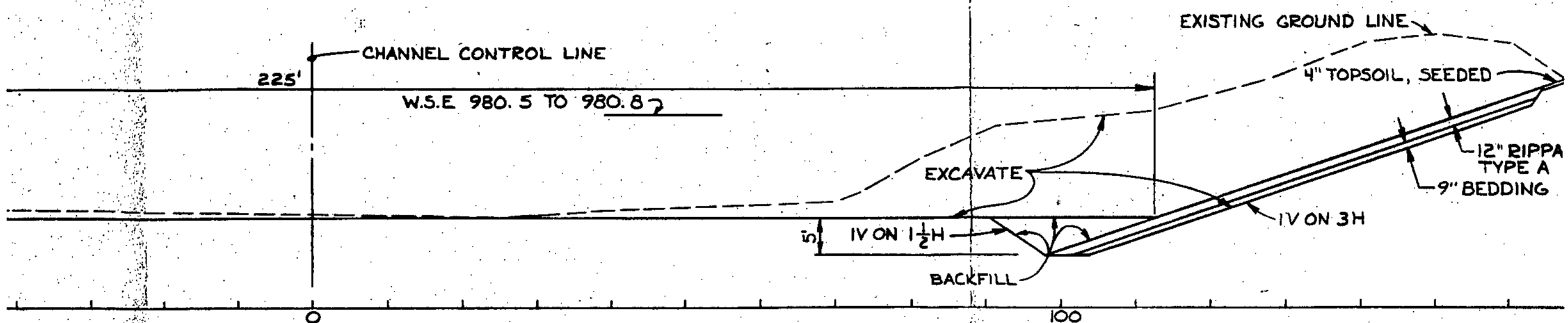
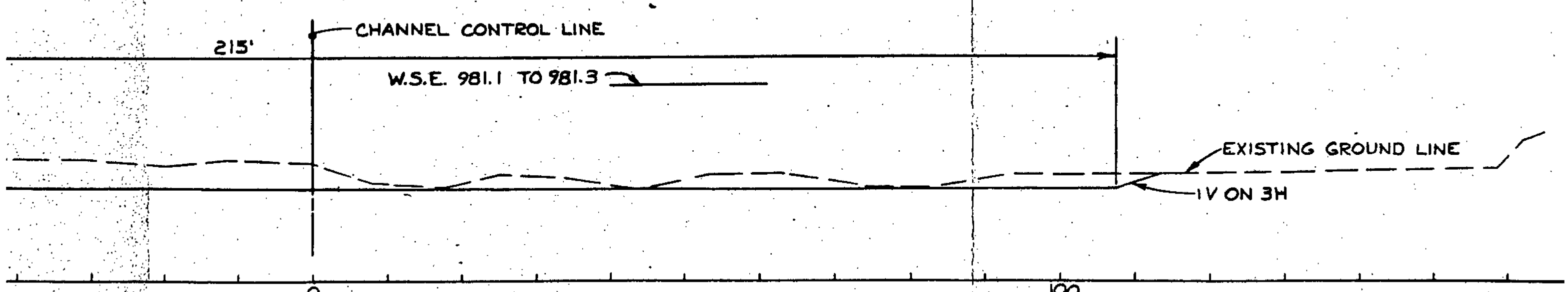


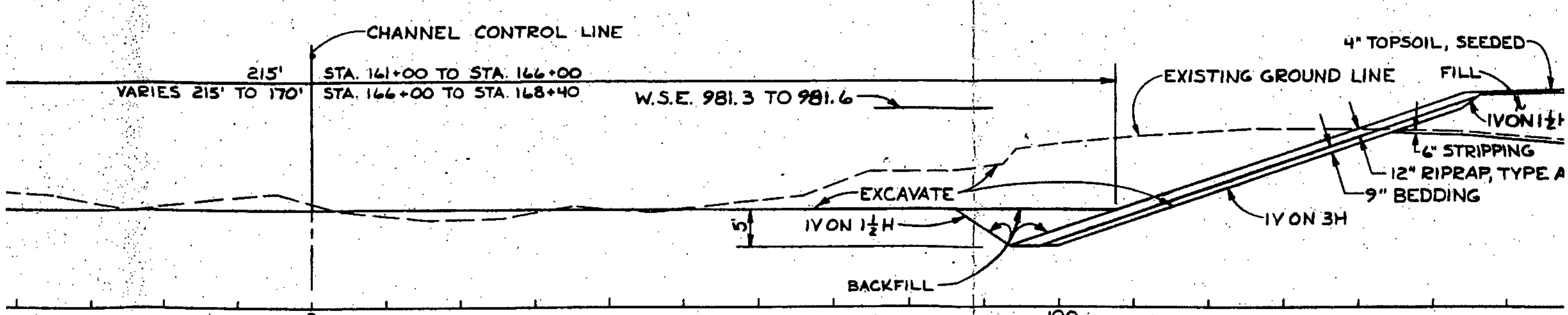
TYPICAL SECTION STA. 126+90 TO 151+30



TYPICAL SECTION STA. 153+50 TO 154+80



TYPICAL SECTION STA. 158+40 TO 161+00



TYPICAL SECTION STA. 161+00 TO 168+40

REFERENCES

ITEMS	SHEET NO.(S)
1. PLANS + PROFILE	16, 17, 18, + 19
2. DETAILS, GATE WELL A	43

2

SYMBOL	DESCRIPTION

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTME
ST. PAUL DISTRIC
ST. PA

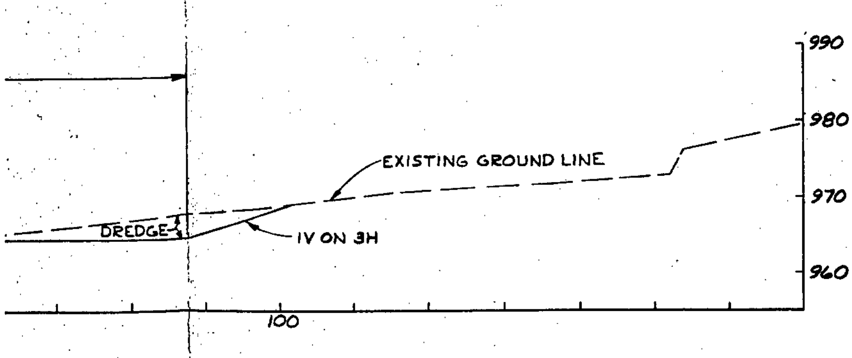
DESIGNED BY: D.O
DRAWN BY: K.R.R.
CHECKED BY: D.O
SUBMITTED BY:

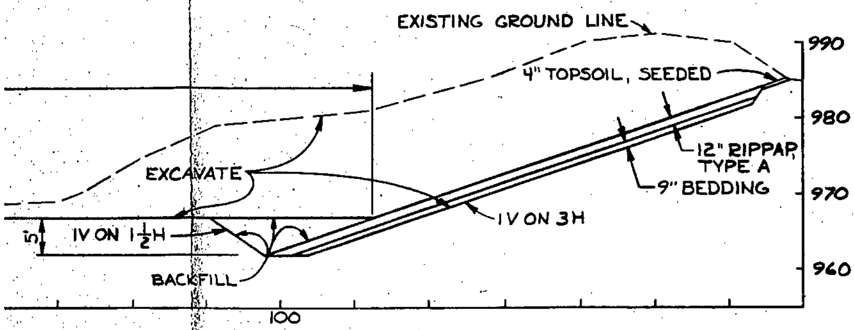
DESIGN MEMORANDUM NO. 2
FLOOD CONTROL SOUTH FOR
ROCHESTER, MINN
STAGE I
TYPICAL SECT
STA. 126+90 TO STA

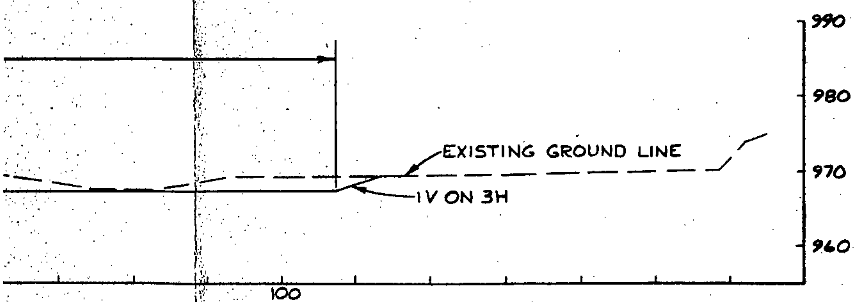
APPROVED BY:

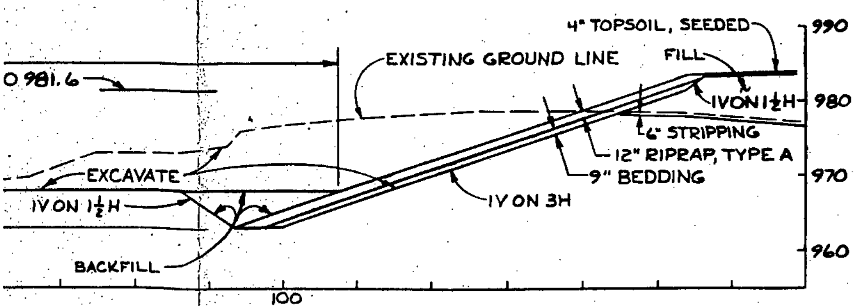
SCALE AS SHOW
DRA
M3
SHEET 12 OF

G H J









SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: D.O
DRAWN BY: K.R.R.
CHECKED BY: D.O
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
TYPICAL SECTIONS
STA. 126+90 TO STA. 168+40

APPROVED BY:
DATE: DECEMBER 1986
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER
M30-R-64/1
SHEET 12 OF 45

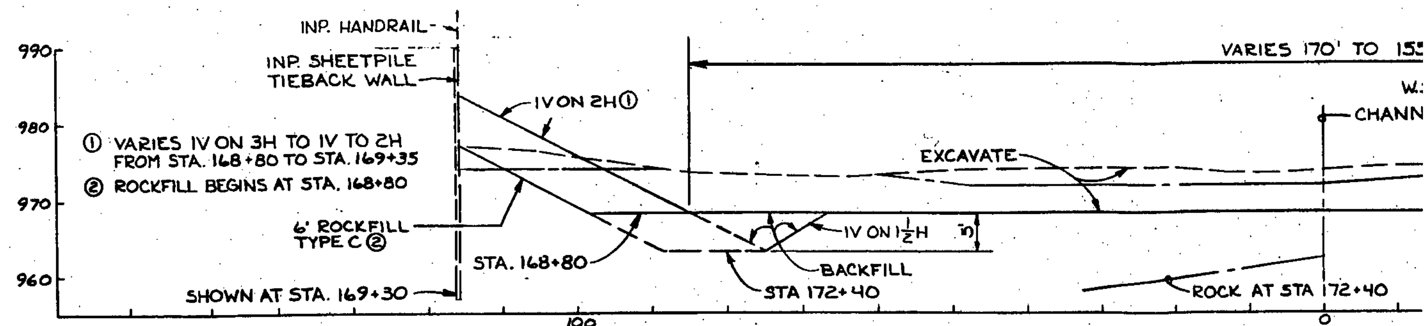
SHEET NO.(S)
16, 17, 18, + 19
43

3

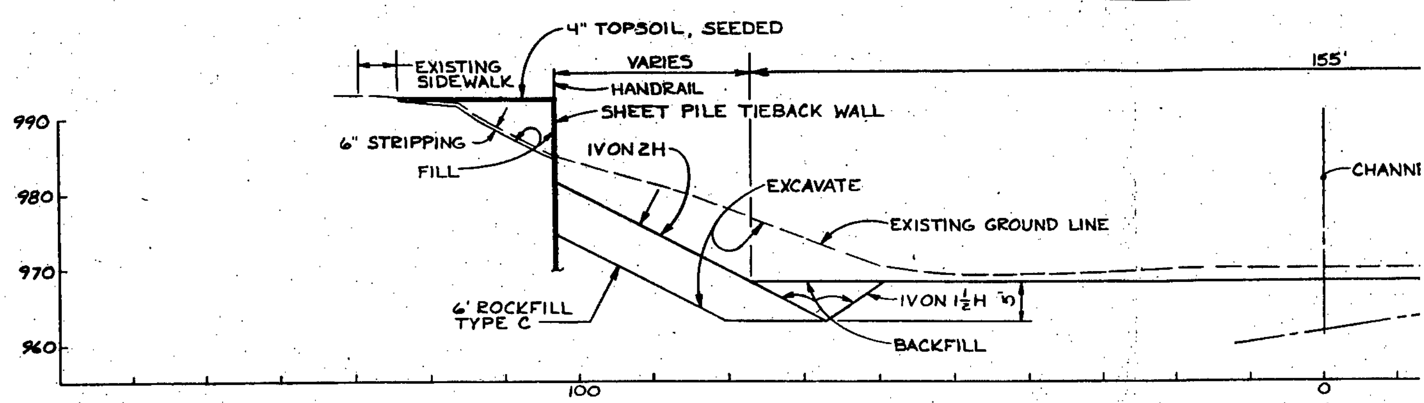
SAFETY PAYS

G

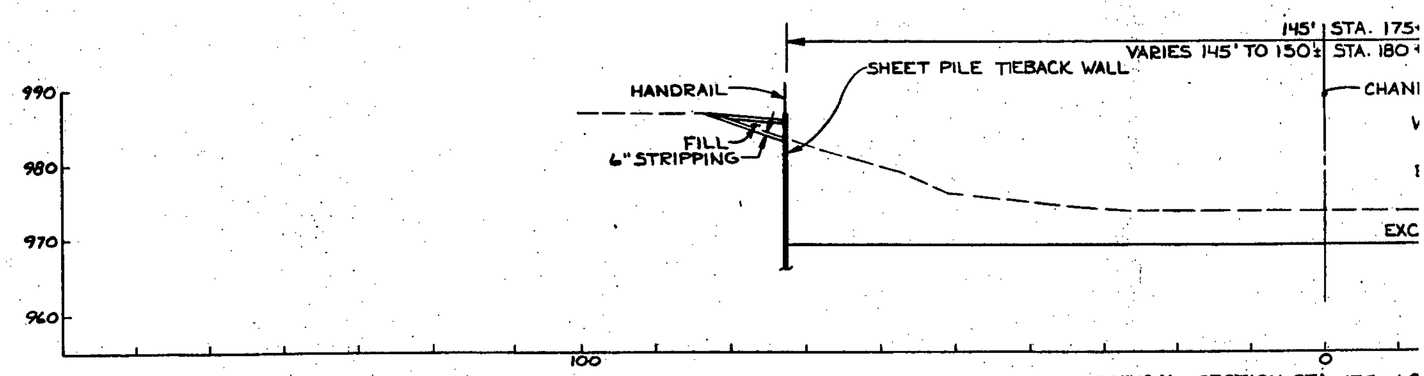
PLATE 12



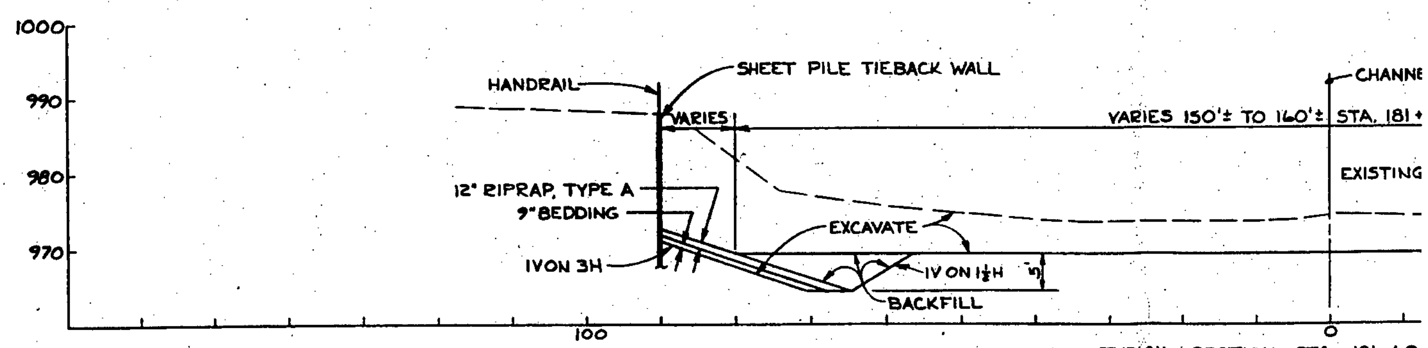
TYPICAL SECTION STA. 168



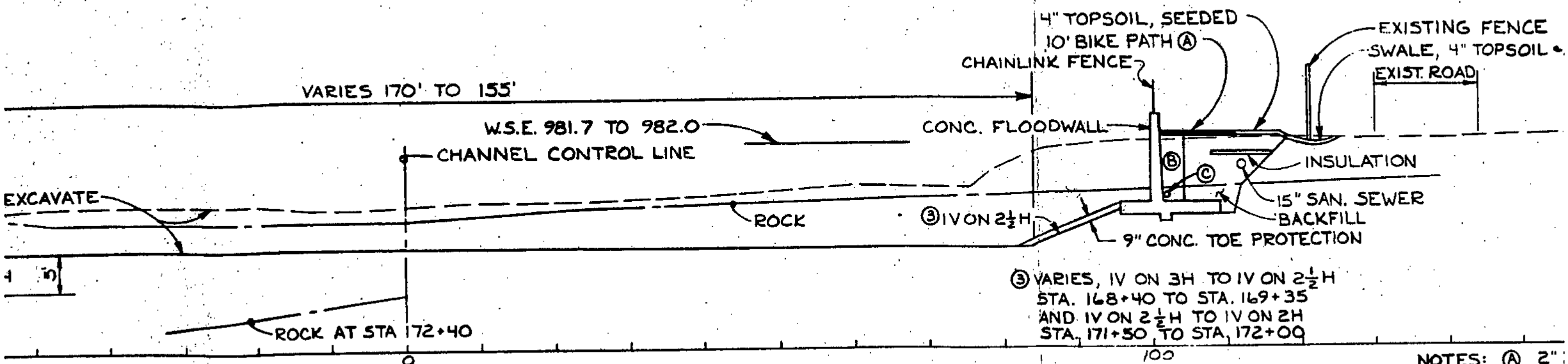
TYPICAL SECTION STA. 172



TYPICAL SECTION STA. 175+6C

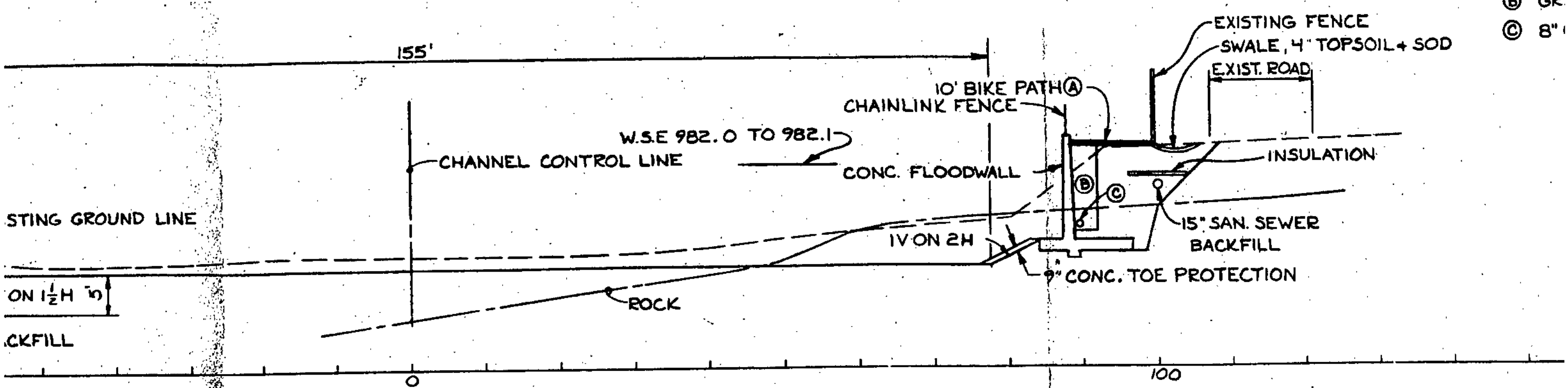


TYPICAL SECTION STA. 181+60

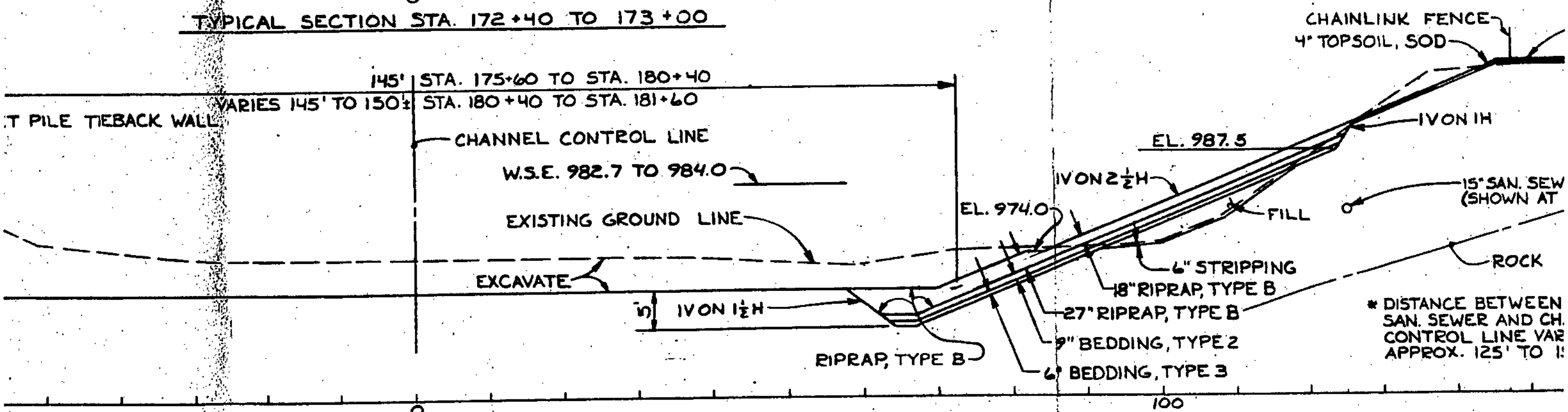


TYPICAL SECTION STA. 168+40 TO 172+40

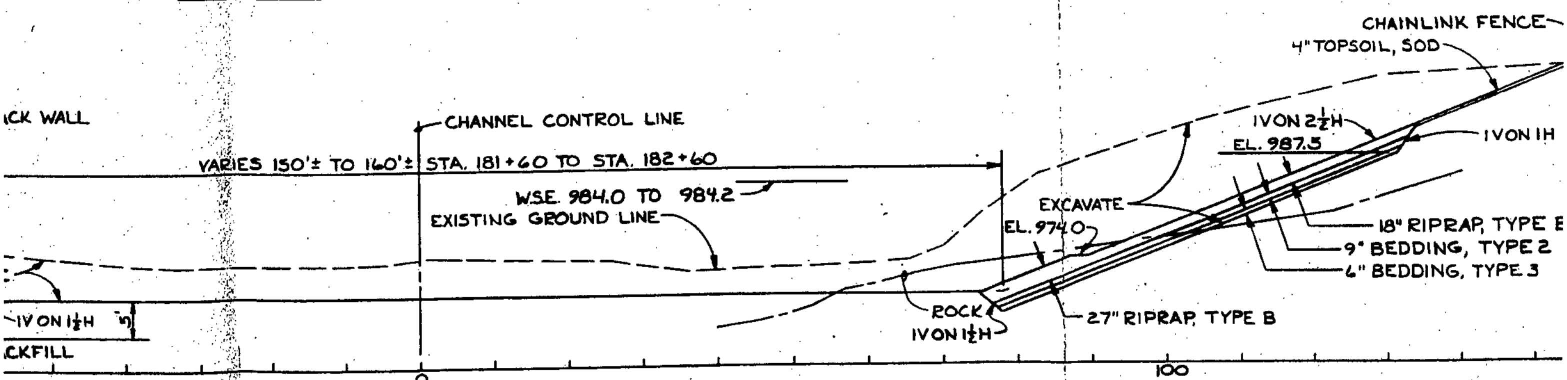
NOTES: Ⓐ 2" ... 4" ...
Ⓑ GR...
Ⓒ 8" ...



TYPICAL SECTION STA. 172+40 TO 173+00



TYPICAL SECTION STA. 175+60 TO 181+60



TYPICAL SECTION STA. 181+60 TO 182+60

REFERENCES

ITEM	SHEET NO.(S)
1. PLAN + PROFILE	19 + 20
2. DAKOTA + MINNESOTA EASTERN R.R. BRIDGE SCOUR PROTECTION	39
3. RT. BANK FLOODWALL STA. 169+40 TO STA. 174+79	42
4. LT. BANK FLOODWALL STA. 172+40 TO STA. 186+25	43
5. BIKE PATH UNDERPASS	45

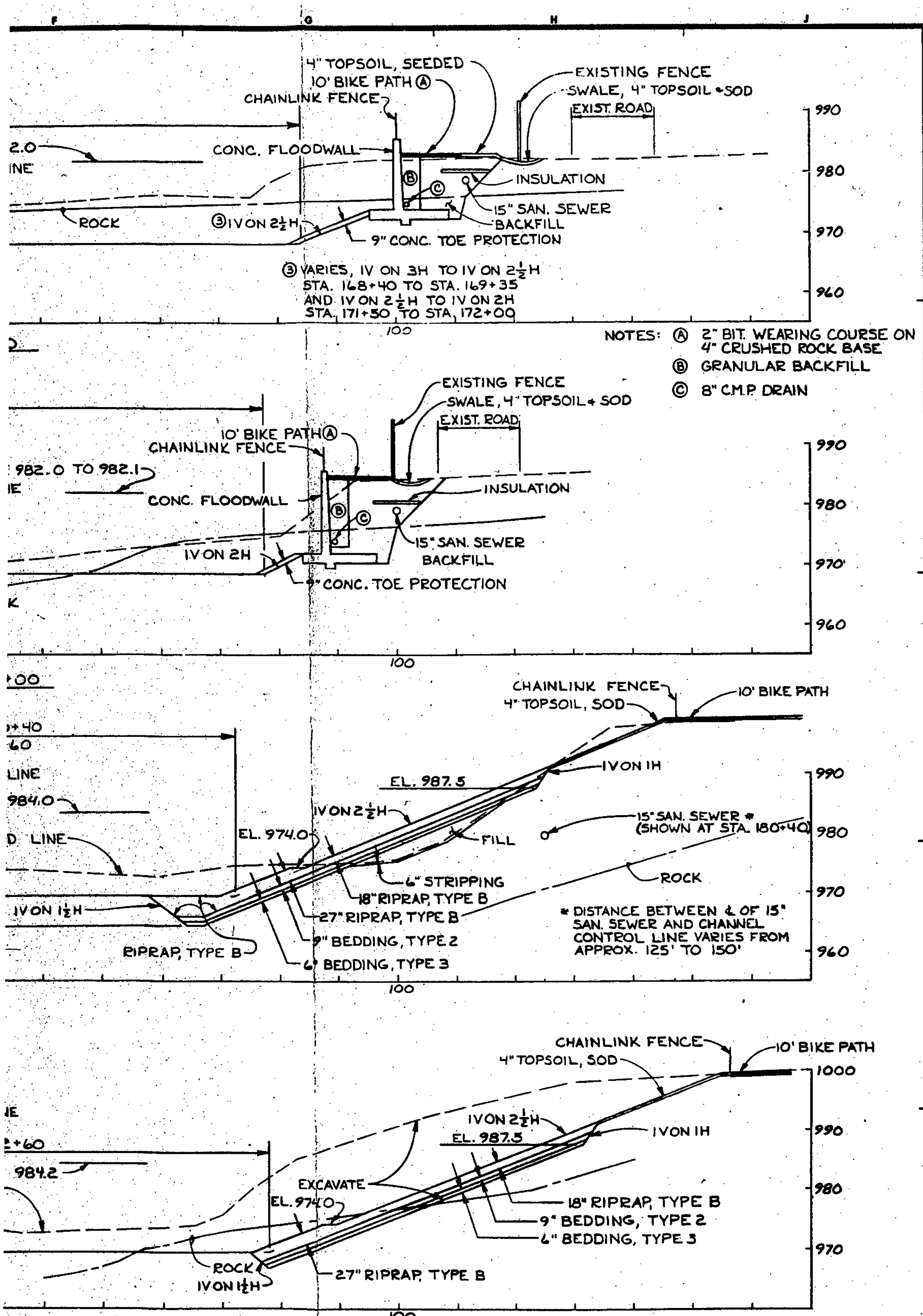
2

SYMBOL | DESCRIPTION

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DESIGNED BY: D.O.
DRAWN BY: K.R.R.
CHECKED BY: D.O.
SUBMITTED BY:
APPROVED BY:

DESIGN MEMORANDUM
FLOOD CONT
ROC
TY
STA. 1



REFERENCES

ITEM	SHEET NO.(S)
PLAN + PROFILE	19 + 20
DAKOTA + MINNESOTA EASTERN RR. BRIDGE SCOUR PROTECTION	39
RT. BANK FLOODWALL STA. 169+40 TO STA. 174+79	42
LT. BANK FLOODWALL STA. 172+40 TO STA. 186+25	43
BIKE PATH UNDERPASS	45

3

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

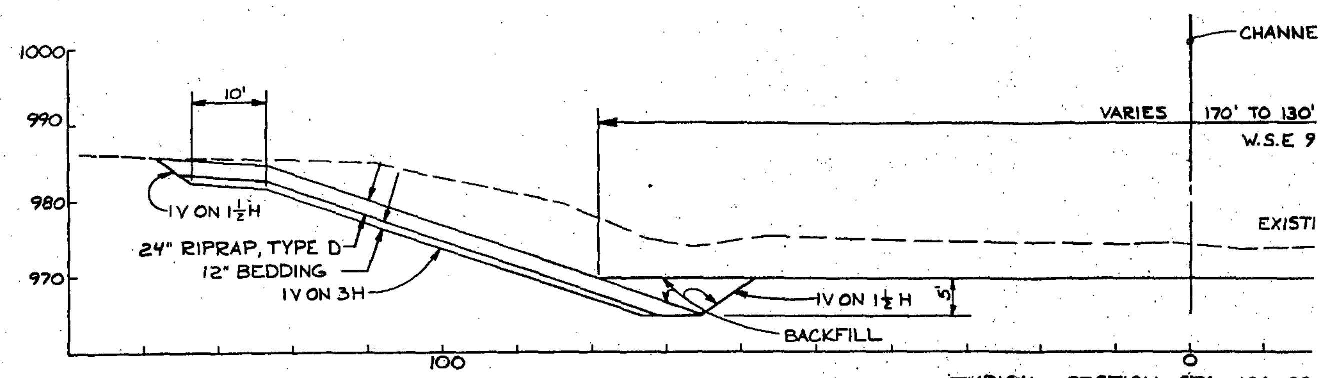
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: D.O.
DRAWN BY: K.R.R.
CHECKED BY: D.O.
SUBMITTED BY:
APPROVED BY:

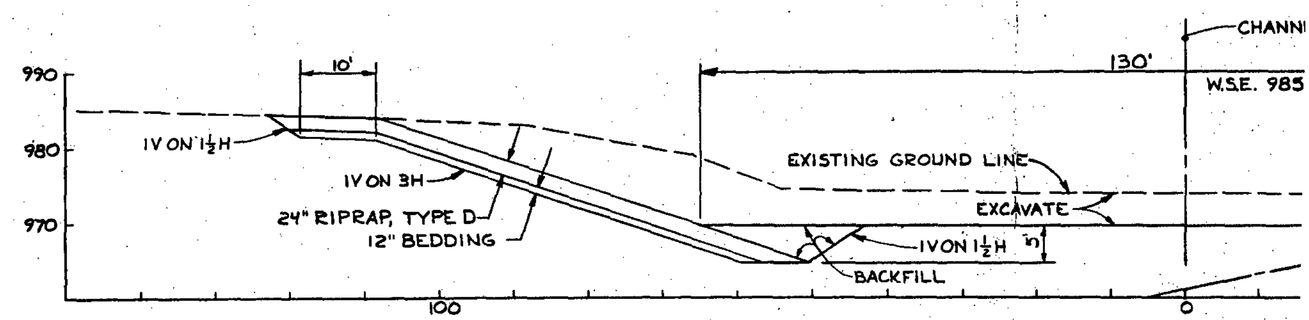
DESIGN MEMORANDUM NO. 2 — FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
TYPICAL SECTIONS
STA. 168+40 TO STA. 182+60

DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-64/2
SHEET 13 OF 45

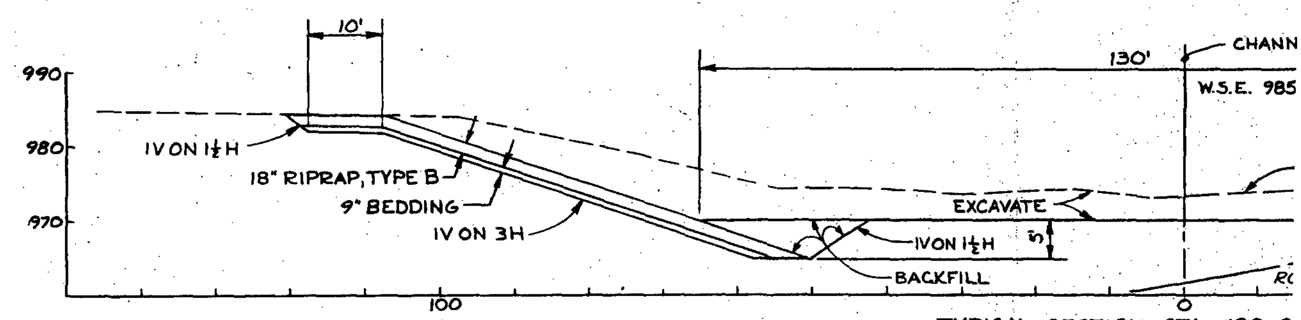
PLATE 13



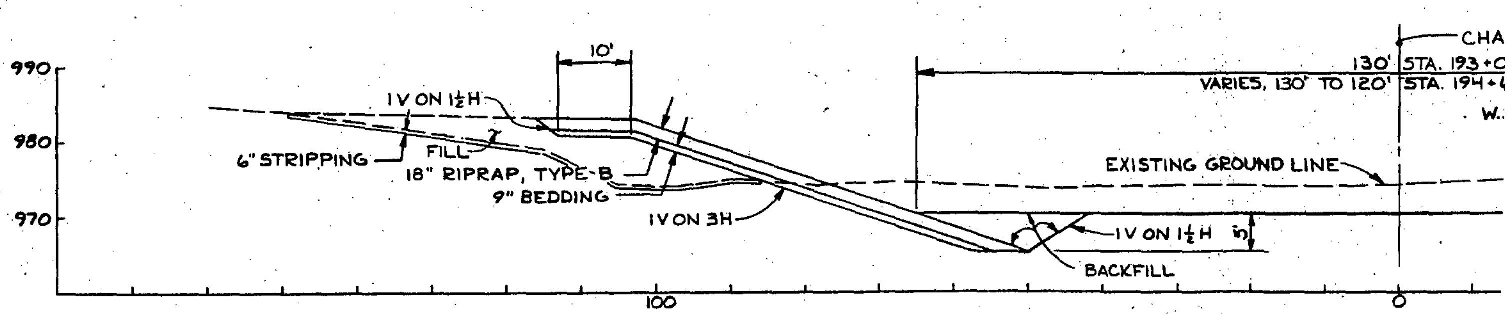
TYPICAL SECTION STA. 186+20



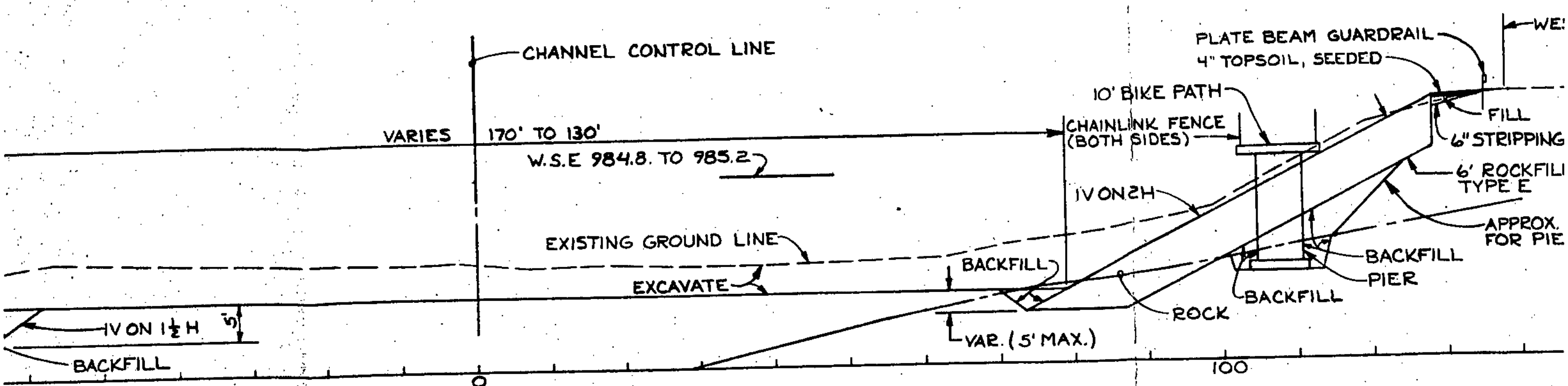
TYPICAL SECTION STA. 188+30



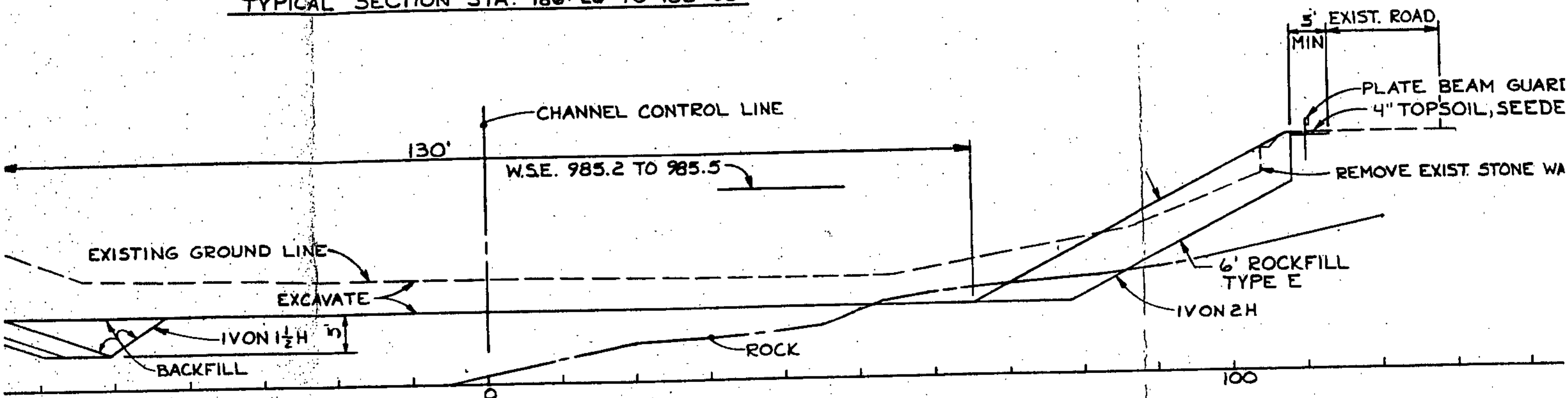
TYPICAL SECTION STA. 190+0



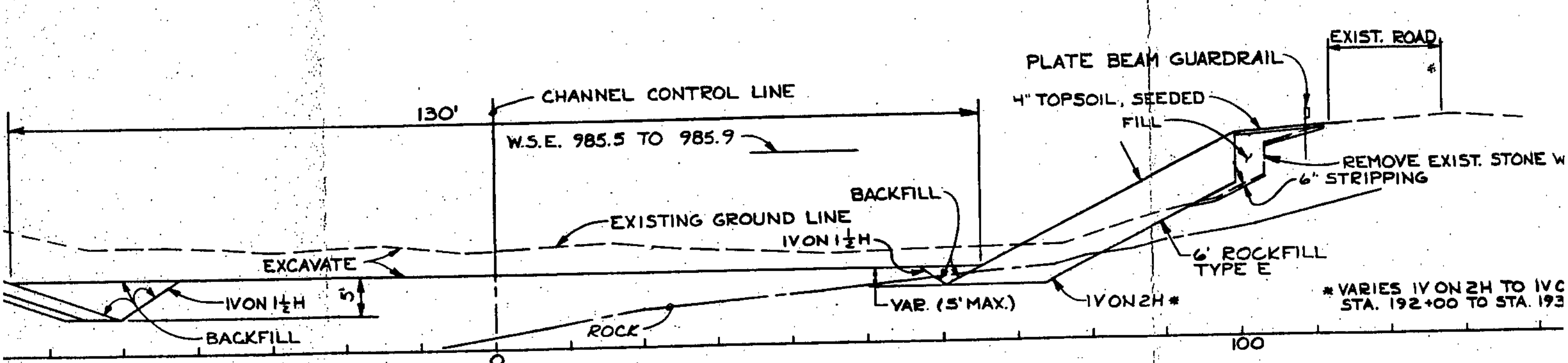
TYPICAL SECTION STA. 193+0



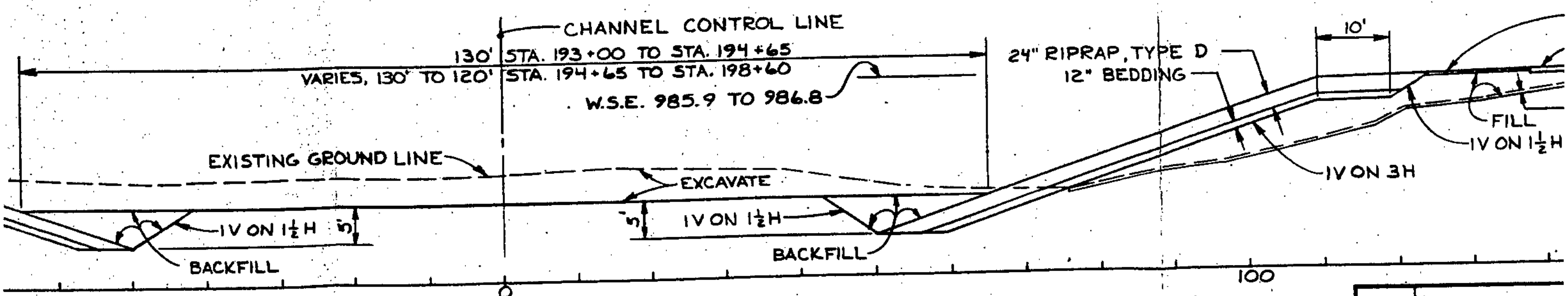
TYPICAL SECTION STA. 186+20 TO 188+30



TYPICAL SECTION STA. 188+30 TO 190+00



TYPICAL SECTION STA. 190+00 TO 193+00



TYPICAL SECTION STA. 193+00 TO 198+60

REFERENCES

ITEMS	SHEET NO.(S)
1. PLAN + PROFILE	21 + 22
2. BIKE PATH UNDERPASS	45

SAFETY PAYS

SYMBOL

WHKS – Professional Engineers & ... Mason City, Ia. – Rochester, Mn. – Dul...

DESIGNED BY: D.O.

DESIGN ...

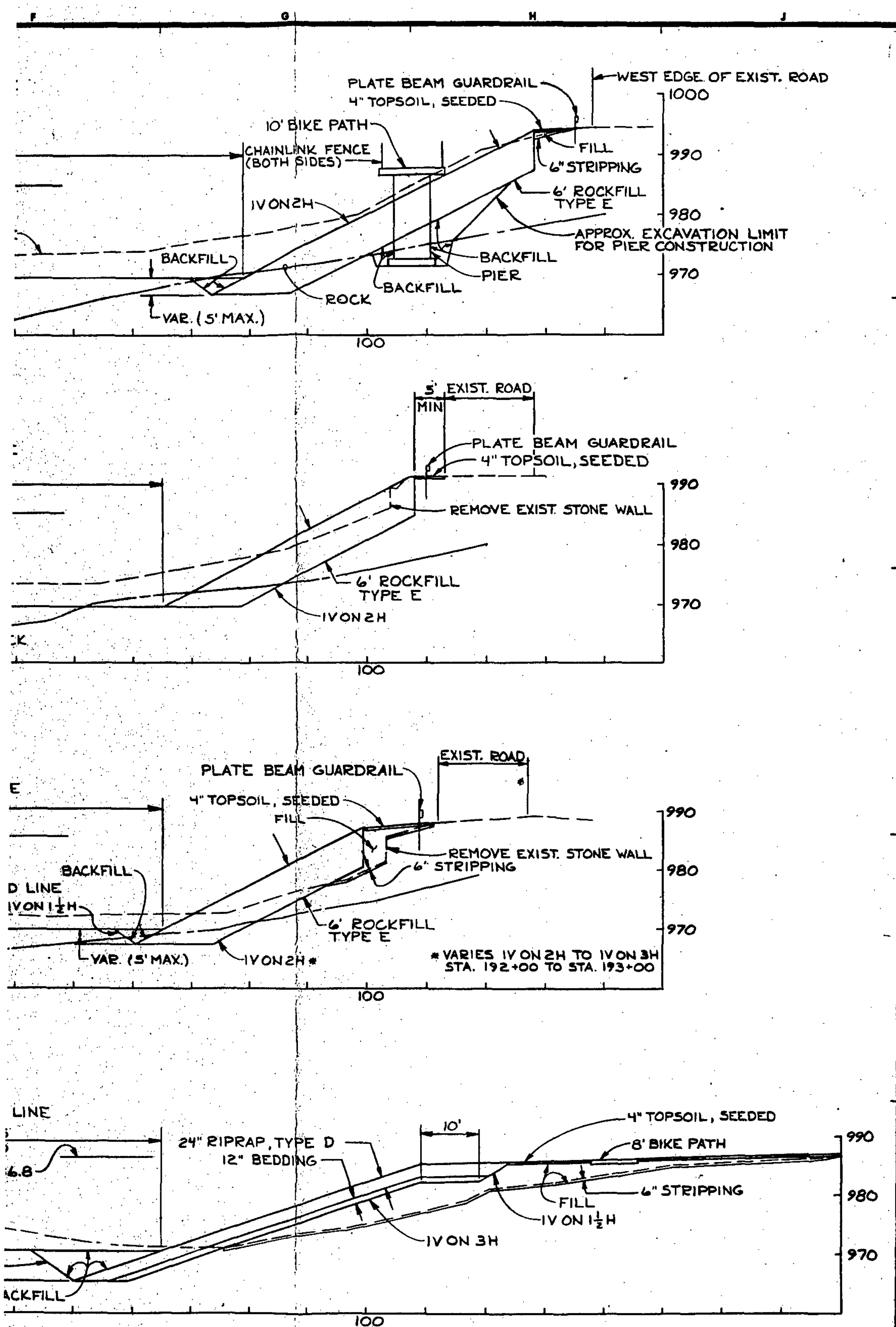
DRAWN BY: K.R.R

CHECKED BY: D.O.

SUBMITTED BY:

APPROV...

2



SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: D.O.
DRAWN BY: K.R.R
CHECKED BY: D.O.
SUBMITTED BY:
APPROVED BY:

DESIGN MEMORANDUM NO. 2 — FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE - 1B
TYPICAL SECTIONS
STA. 186+20 TO STA. 198+60

DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-64/3
SHEET 14 OF 45

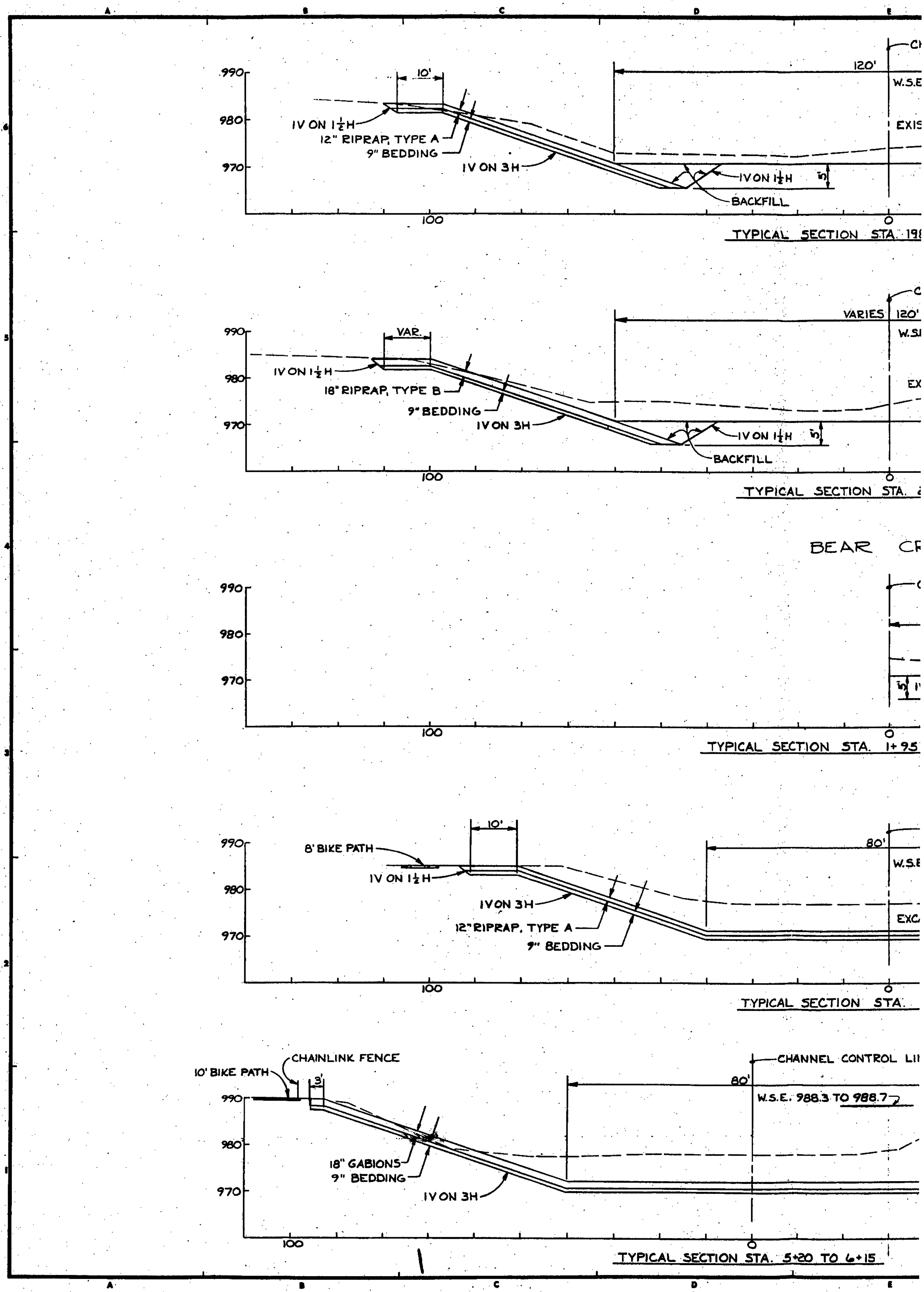
REFERENCES

	SHEET NO.(S)
PROFILE	21 + 22
H UNDERPASS	45

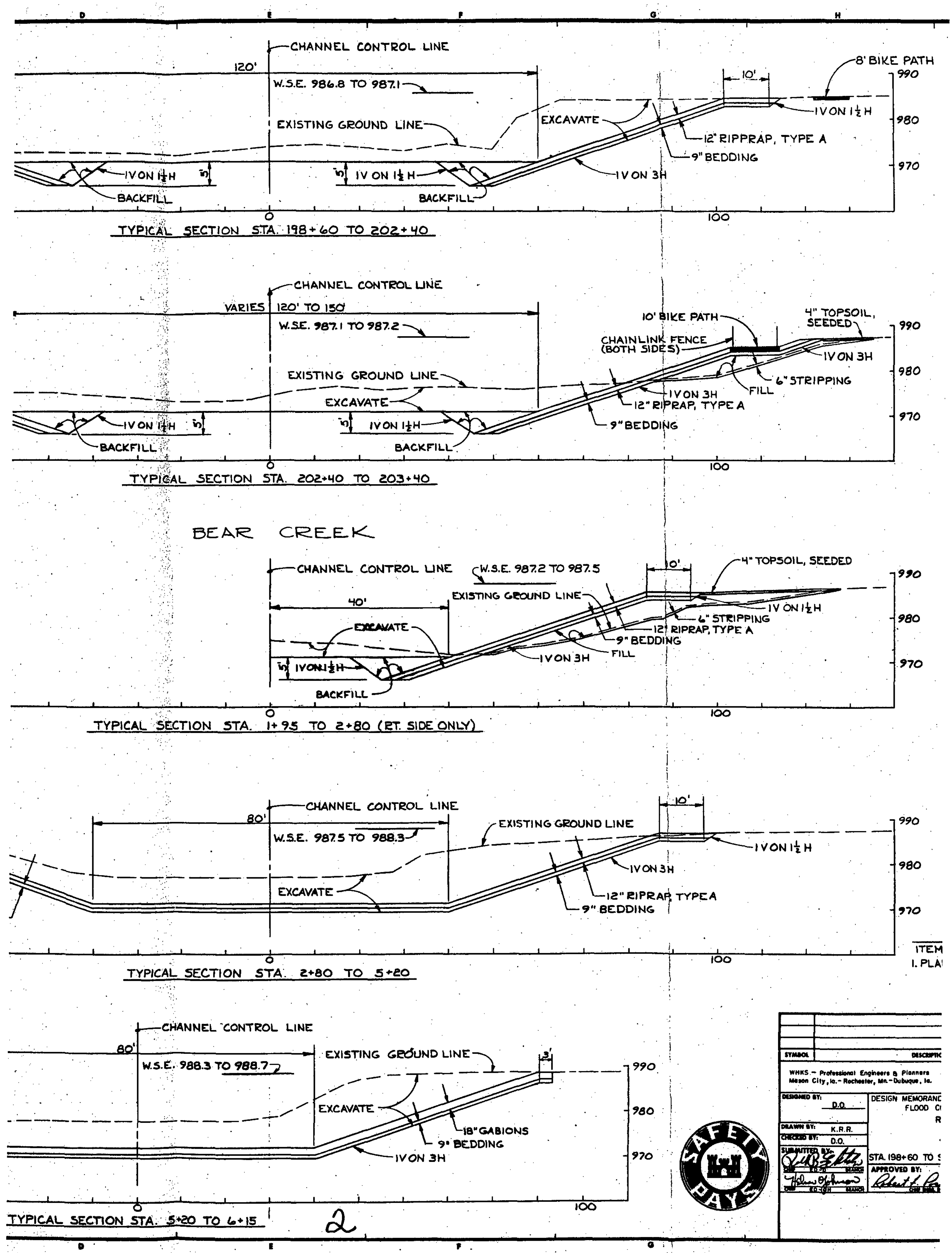
SAFETY PAYS

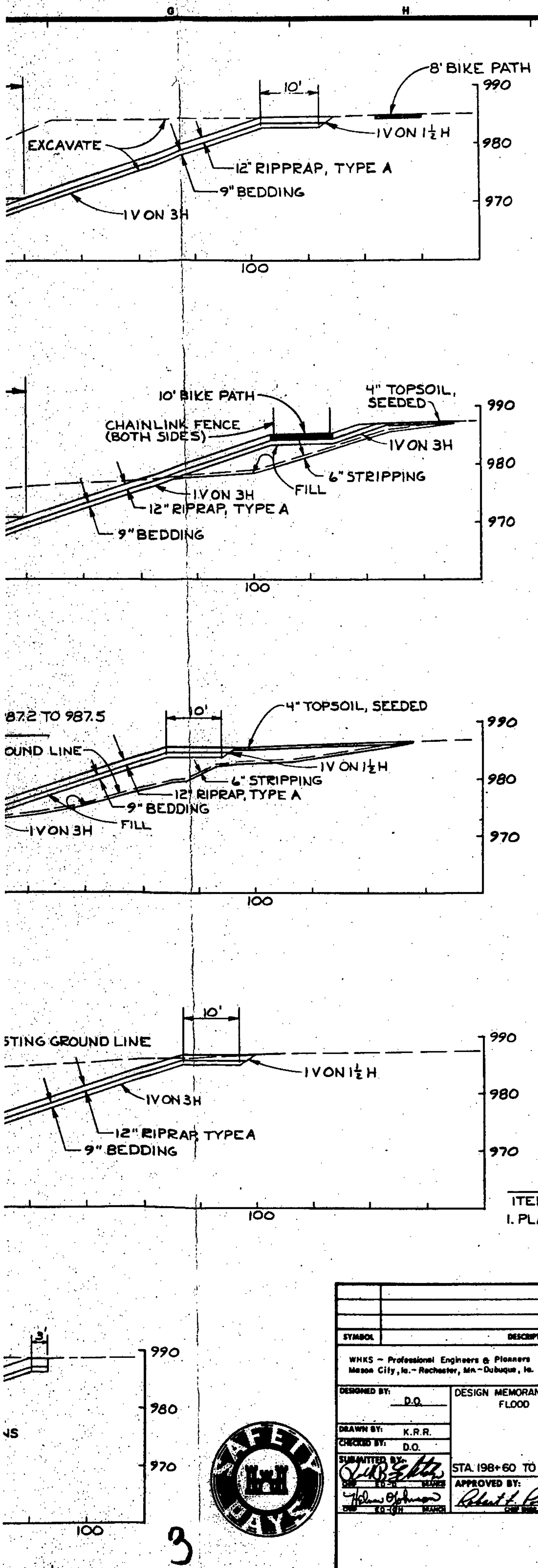
3

PLATE 14



120'
W.S.E
EXIS
10'
IV ON 1½H
12" RIPRAP, TYPE A
9" BEDDING
IV ON 3H
IV ON 1½H
BACKFILL
990
980
970
100
0
TYPICAL SECTION STA. 19
VARIES
120'
W.S.
EX
VAR.
IV ON 1½H
18" RIPRAP, TYPE B
9" BEDDING
IV ON 3H
IV ON 1½H
BACKFILL
TYPICAL SECTION STA.
BEAR CR
TYPICAL SECTION STA. 1+95
10'
8' BIKE PATH
IV ON 1½H
IV ON 3H
12" RIPRAP, TYPE A
9" BEDDING
80'
W.S.E
EXC
TYPICAL SECTION STA.
CHAINLINK FENCE
10' BIKE PATH
3'
CHANNEL CONTROL LI
80'
W.S.E. 988.3 TO 988.7
18" GABIONS
9" BEDDING
IV ON 3H
TYPICAL SECTION STA. 5+20 TO 6+15


D
E
F
G
H
CHANNEL CONTROL LINE
120'
W.S.E. 986.8 TO 987.1
10'
8' BIKE PATH
990
980
970
EXISTING GROUND LINE
EXCAVATE
1V ON 1½H
12" RIPRAP, TYPE A
9" BEDDING
1V ON 3H
BACKFILL
0
100
TYPICAL SECTION STA. 198+60 TO 202+40
CHANNEL CONTROL LINE
VARIES 120' TO 150'
W.S.E. 987.1 TO 987.2
10' BIKE PATH
4" TOPSOIL, SEEDED
CHAINLINK FENCE (BOTH SIDES)
1V ON 3H
6" STRIPPING
FILL
EXISTING GROUND LINE
EXCAVATE
12" RIPRAP, TYPE A
9" BEDDING
1V ON 1½H
BACKFILL
TYPICAL SECTION STA. 202+40 TO 203+40
BEAR CREEK
CHANNEL CONTROL LINE
W.S.E. 987.2 TO 987.5
10'
4" TOPSOIL, SEEDED
40'
EXISTING GROUND LINE
1V ON 1½H
6" STRIPPING
EXCAVATE
12" RIPRAP, TYPE A
9" BEDDING
FILL
1V ON 3H
BACKFILL
TYPICAL SECTION STA. 1+95 TO 2+80 (RT. SIDE ONLY)
CHANNEL CONTROL LINE
10'
80'
EXISTING GROUND LINE
W.S.E. 987.5 TO 988.3
1V ON 1½H
1V ON 3H
EXCAVATE
12" RIPRAP TYPE A
9" BEDDING
TYPICAL SECTION STA. 2+80 TO 5+20
ITEM
1. PLA
CHANNEL CONTROL LINE
80'
EXISTING GROUND LINE
3'
W.S.E. 988.3 TO 988.7
EXCAVATE
18" GABIONS
9" BEDDING
1V ON 3H
TYPICAL SECTION STA. 5+20 TO 6+15
2
SAFETY PAYS
SYMBOL
DESCRIPTIO
WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.
DESIGNED BY: D.O.
DRAWN BY: K.R.R.
CHECKED BY: D.O.
SUBMITTED BY:
DESIGN MEMORAND
FLOOD C
STA. 198+60 TO
APPROVED BY:



REFERENCES

ITEMS	SHEET NO.
1. PLAN + PROFILE	22 + 23

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS ~ Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

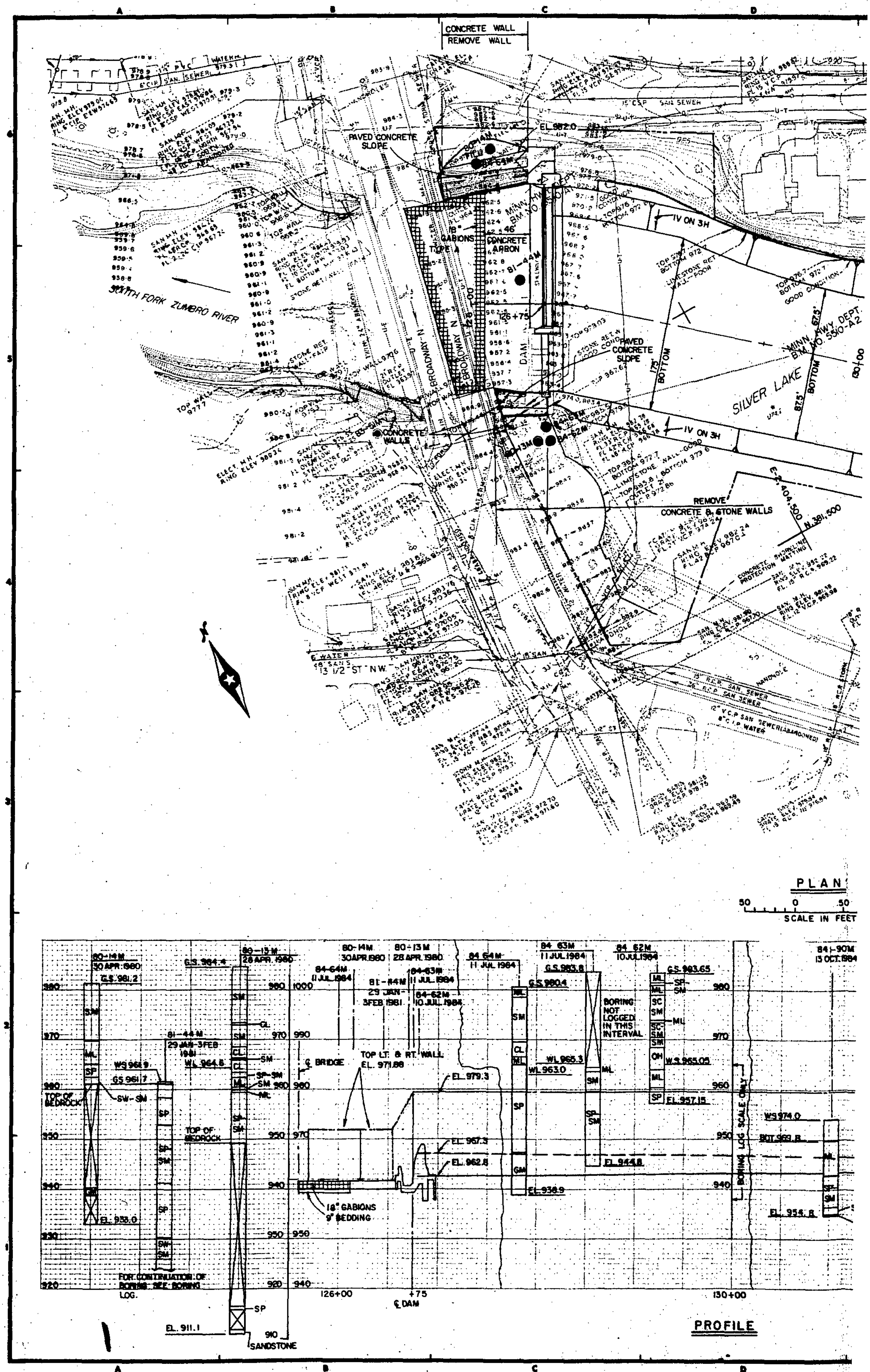
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: D.O.
DRAWN BY: K.R.R.
CHECKED BY: D.O.
SUBMITTED BY:
APPROVED BY:

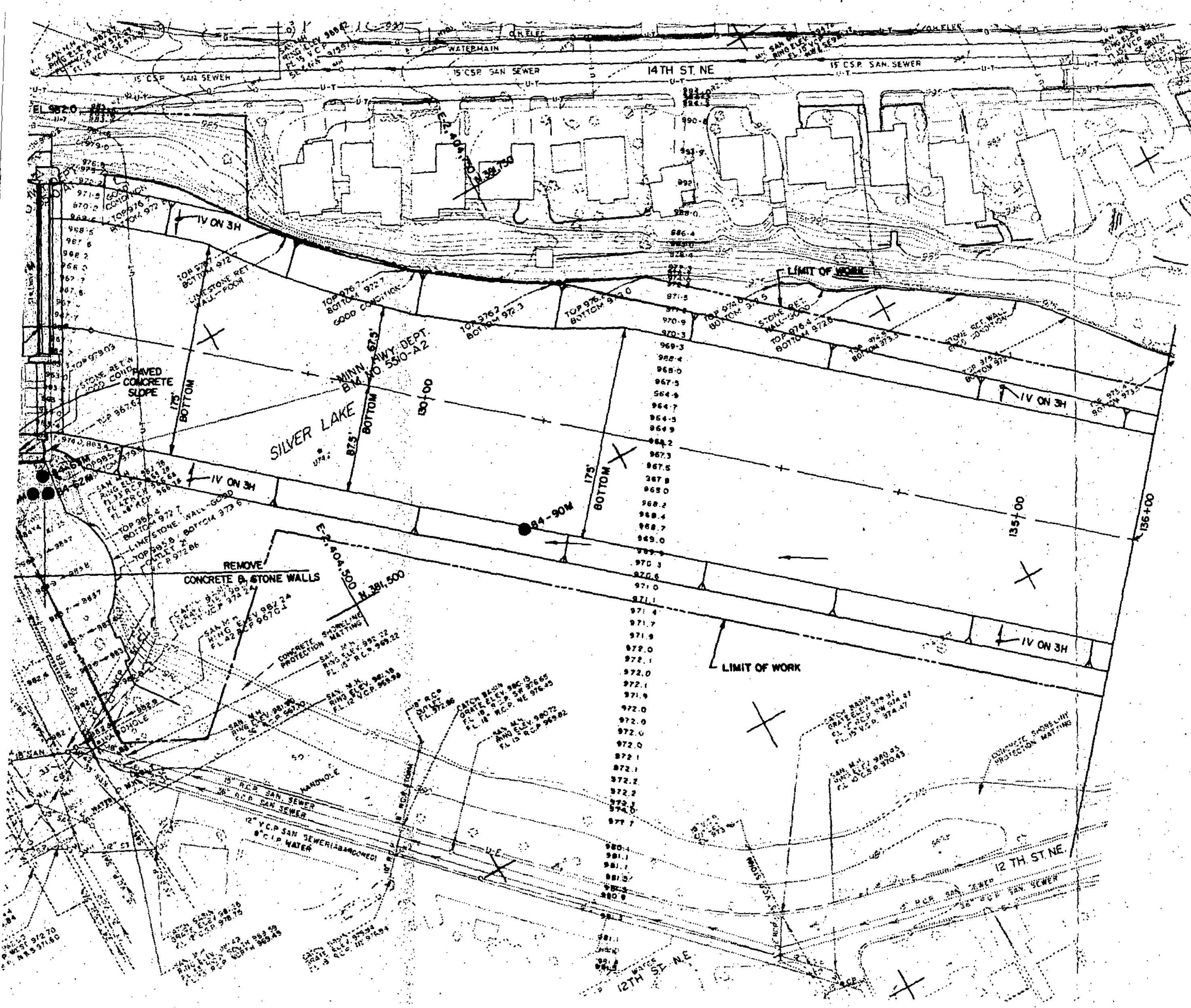
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
TYPICAL SECTIONS
STA. 198+60 TO STA. 203+40 & STA. 1+95 TO STA 6+15

DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER M30-R-64/4
SHEET 15 OF 45

3

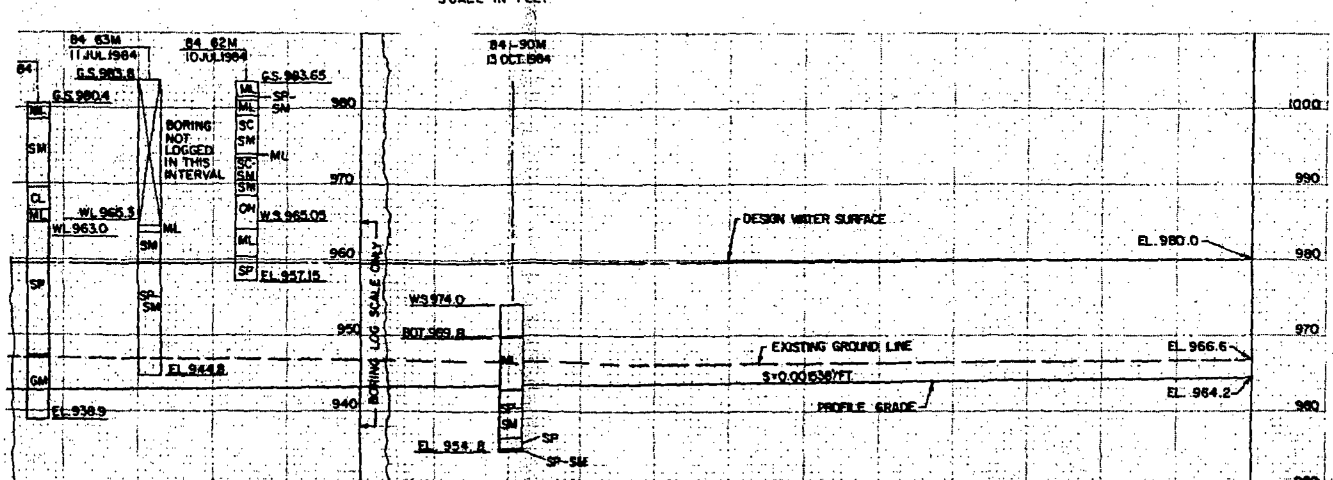


CONCRETE WALL
REMOVE WALL
SOUTH FORK ZUMBRO RIVER
PAVED CONCRETE SLOPE
EL. 982.0
18" GABIONS TYPE A
CONCRETE APRON
BROADWAY N.
DAM
SILVER LAKE
CONCRETE WALLS
REMOVE CONCRETE & STONE WALLS
1V ON 3H
13 1/2 ST. N.W.
PLAN
SCALE IN FEET
TOP OF BEDROCK
FOR CONTINUATION OF BORING SEE BORING LOG.
EL. 911.1
910 SANDSTONE
℄ BRIDGE
TOP LT. & RT. WALL EL. 971.88
EL. 979.3
EL. 967.3
EL. 962.8
18" GABIONS 9" BEDDING
BORING NOT LOGGED IN THIS INTERVAL
BORING LOG SCALE ONLY
126+00
+75
℄ DAM
130+00
PROFILE



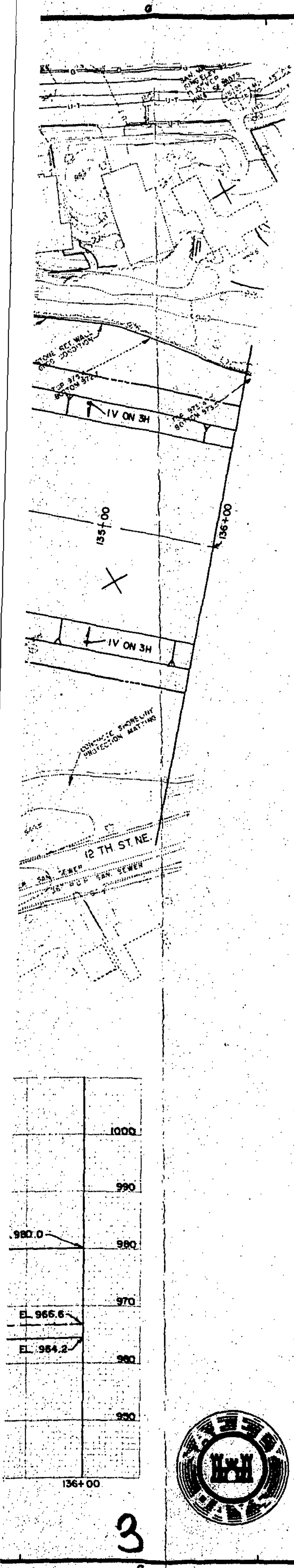
PLAN

50 0 50 100
SCALE IN FEET



PROFILE

2



3

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

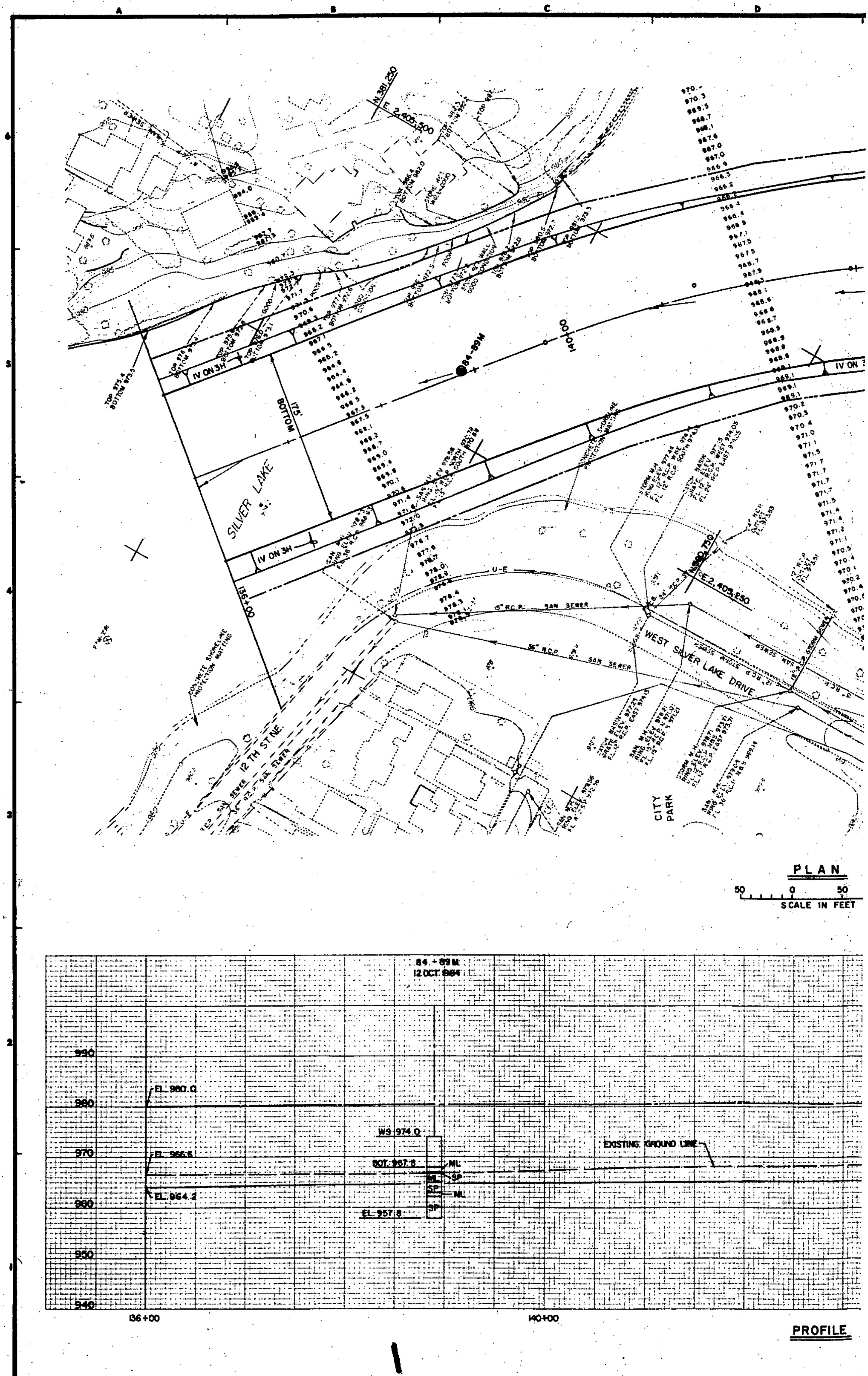
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

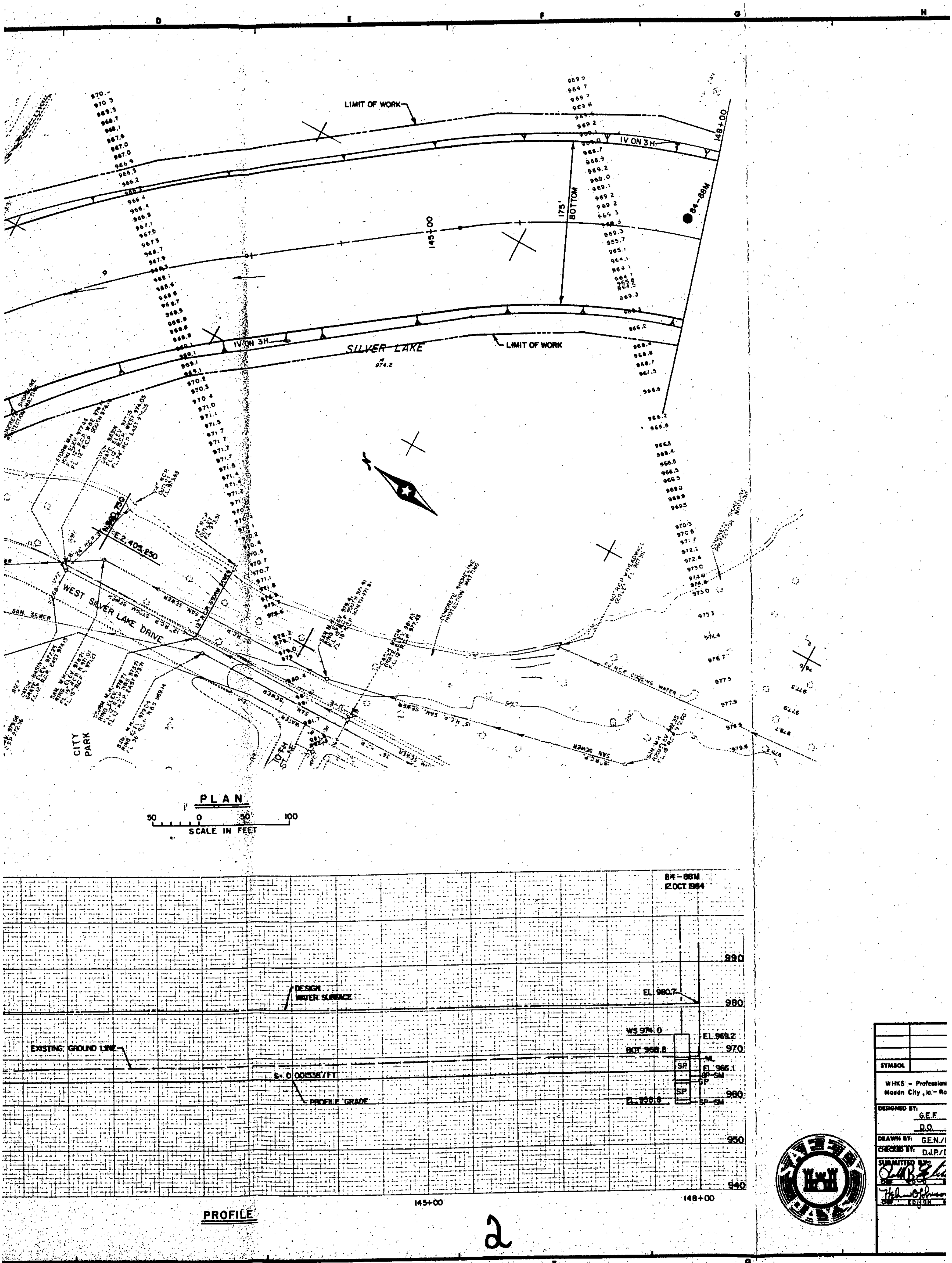
DESIGNED BY: G.E.F. / D.O.
DRAWN BY: G.E.N./K.R.R.
CHECKED BY: D.J.P. / D.O.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 — FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
PLAN AND PROFILE
126+00 TO 136+00

APPROVED BY:
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-64/5
SHEET 16 OF 45

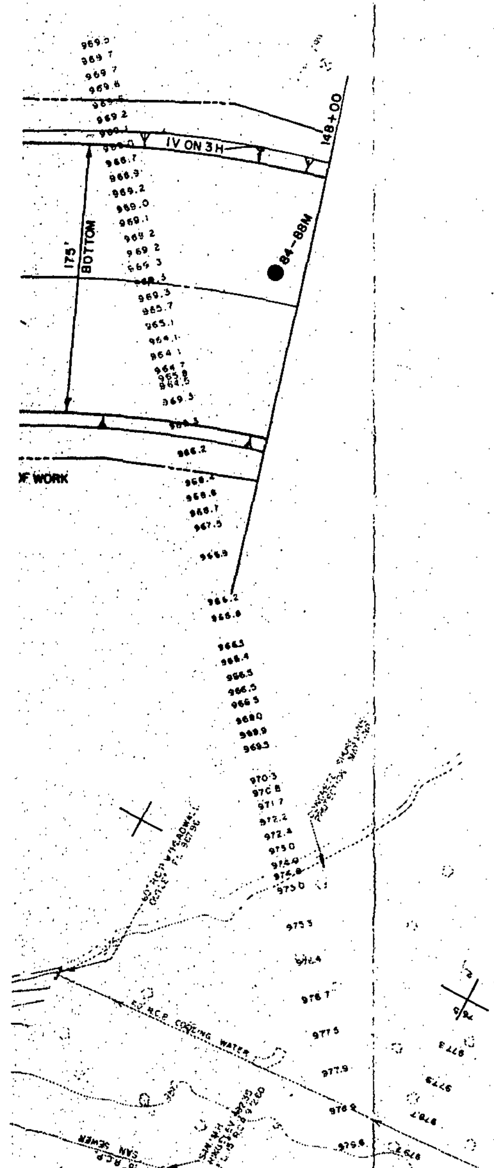
PLATE 16

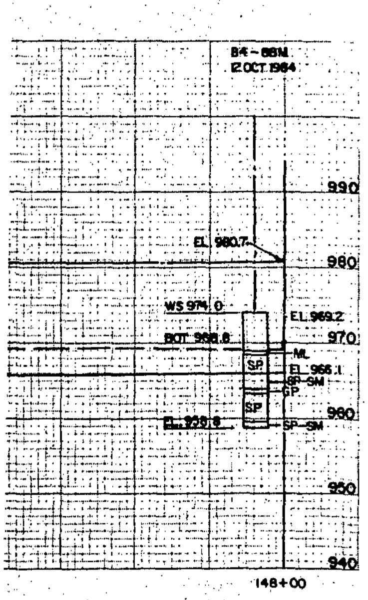

N 381,250
E 2,405,500
SILVER LAKE
BOTTOM
175'
IV ON 3H
84-89M
140+00
136+00
WEST SILVER LAKE DRIVE
12 TH ST NE
CITY PARK
15" R.C.P. SAN SEWER
36" R.C.P. SAN SEWER
N 380,750
E 2,405,250
CONCRETE SHORELINE PROTECTION MATTING
PLAN
50 0 50
SCALE IN FEET
84 - 89M
12 OCT 1984
990
980
970
960
950
940
EL 980.0
EL 966.6
EL 964.2
WS 974.0
BOT 967.6
ML
SP
EL 957.8
EXISTING GROUND LINE
136+00
140+00
PROFILE
A
B
C
D



LIMIT OF WORK
IV ON 3H
148+00
145+00
175' BOTTOM
84-68M
SILVER LAKE
974.2
LIMIT OF WORK
IV ON 3H
WEST SILVER LAKE DRIVE
SAN. SEWER
CITY PARK
E.2,405,250
PLAN
50 0 50 100
SCALE IN FEET
84-68M
12 OCT 1984
990
980
970
960
950
940
EL 980.7
DESIGN WATER SURFACE
WS 974.0
EL 969.2
BOT 968.8
EXISTING GROUND LINE
ML
EL 966.1
SP
SP-SM
S= 0.001538'/FT
PROFILE GRADE
EL 958.8
SP-SM
145+00
148+00
PROFILE
SYMBOL
WHKS - Professional
Mason City, Ia. - Ro
DESIGNED BY: G.E.F.
D.O.
DRAWN BY: G.E.N./
CHECKED BY: D.J.P./
SUBMITTED BY:

2





3

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: G.E.F. D.O.
DRAWN BY: G.E.N./K.R.R.
CHECKED BY: D.J.P./D.O.
SUBMITTED BY: CHIEF BRANCH
CHIEF BRANCH

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
PLAN AND PROFILE
136+00 TO 148+00

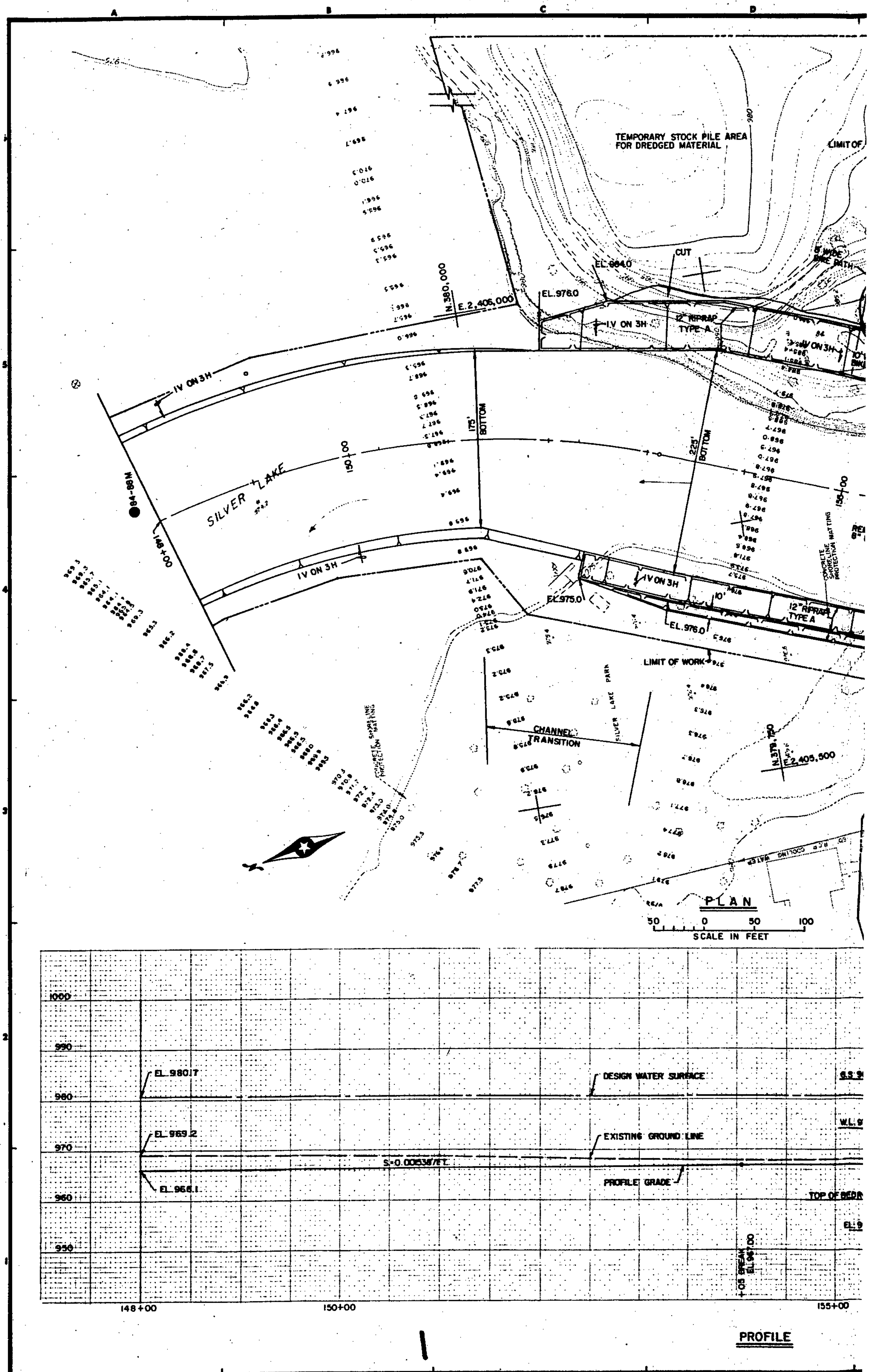
APPROVED BY: CHIEF ENGR. DIVISION

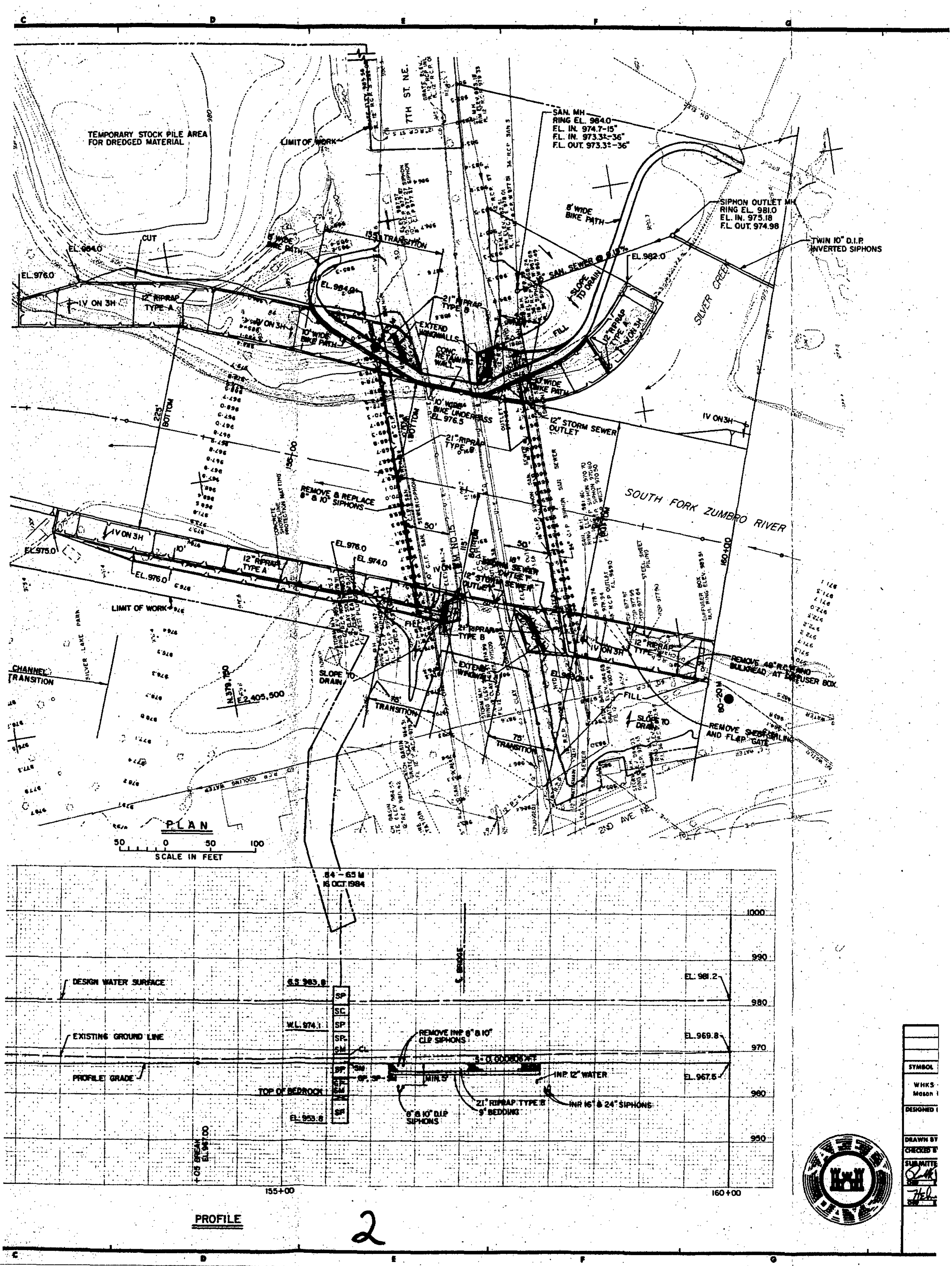
DATE: DECEMBER 1986

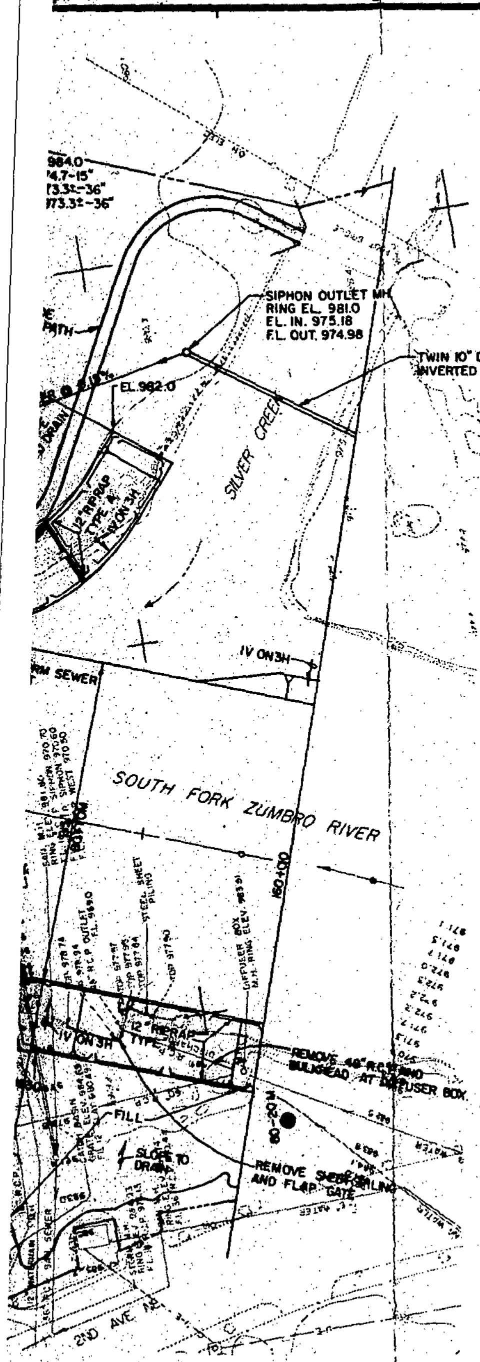
SCALE: AS SHOWN
SPEC. NO.:

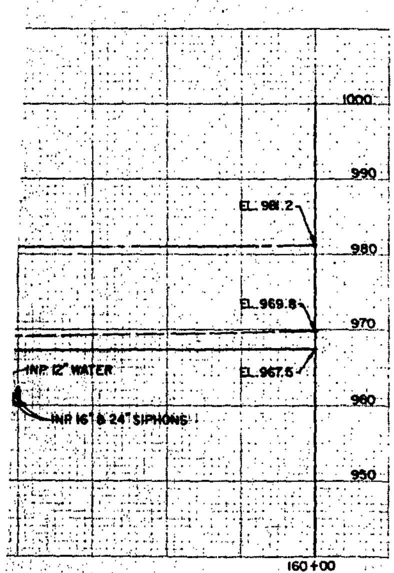
DRAWING NUMBER
M30-R-64/6
SHEET 17 OF 48

PLATE 17


TEMPORARY STOCK PILE AREA FOR DREDGED MATERIAL
LIMIT OF
CUT
EL. 984.0
EL. 976.0
N. 380,000
E. 2,406,000
1V ON 3H
12" RIPRAP TYPE A
175' BOTTOM
225' BOTTOM
SILVER LAKE
150+00
148+00
84-88M
EL. 975.0
10'
EL. 976.0
LIMIT OF WORK
CONCRETE SHORELINE PROTECTION MATTING
CHANNEL TRANSITION
SILVER LAKE PARK
N. 378,750
E. 2,405,500
PLAN
50 0 50 100
SCALE IN FEET
1000
990
980
970
960
950
EL. 980.7
DESIGN WATER SURFACE
EL. 969.2
EXISTING GROUND LINE
S=0.00538'/FT.
PROFILE GRADE
EL. 966.1
TOP OF BEDR
+05 BREAK EL. 967.00
148+00
150+00
155+00
PROFILE


TEMPORARY STOCK PILE AREA FOR DREDGED MATERIAL
LIMIT OF WORK
7TH ST. N.E.
SAN. MH RING EL. 984.0 F.L. IN. 974.7-15" F.L. IN. 973.3±-36" F.L. OUT. 973.3±-36"
8' WIDE BIKE PATH
SIPHON OUTLET MH RING EL. 981.0 F.L. IN. 975.18 F.L. OUT. 974.98
TWIN 10" D.I.P. INVERTED SIPHONS
EL. 984.0
CUT
EL. 976.0
1V ON 3H
12" RIPRAP TYPE A
EL. 984.0
10' WIDE BIKE PATH
EXTEND WINGWALLS
CONC. RETAINING WALL
21" RIPRAP TYPE B
EL. 982.0
SLOPE TO DRAIN
FILL
SILVER CREEK
10' WIDE BIKE PATH
10' WIDE BIKE UNDERPASS EL. 976.5
12" STORM SEWER OUTLET
225' BOTTOM
REMOVE & REPLACE 8" & 10" SIPHONS
SOUTH FORK ZUMBRO RIVER
EL. 975.0
EL. 976.0
EL. 974.0
LIMIT OF WORK
18" STORM SEWER OUTLET
12" STORM SEWER OUTLET
REMOVE 48" R.C.P. AND BULKHEAD AT DIFFUSER BOX
CHANNEL TRANSITION
SILVER LAKE PARK
N. 379,750
E. 2,405,500
SLOPE TO DRAIN
75' TRANSITION
FILL
REMOVE SHEET PILING AND FLAP GATE
2ND AVE. NE
PLAN
SCALE IN FEET
84 - 65 M 16 OCT. 1984
DESIGN WATER SURFACE
EXISTING GROUND LINE
PROFILE GRADE
TOP OF BEDROCK
W.L. 974.1
EL. 953.8
REMOVE INP 8" & 10" C.I.P. SIPHONS
MIN. 5'
INP 12" WATER
21" RIPRAP TYPE B 9" BEDDING
INP 16" & 24" SIPHONS
8" & 10" D.I.P. SIPHONS
EL. 981.2
EL. 969.8
EL. 967.5
155+00
160+00
PROFILE
SYMBOL
DESIGNED
DRAWN BY
CHECKED BY
SUBMITTED
2





3

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

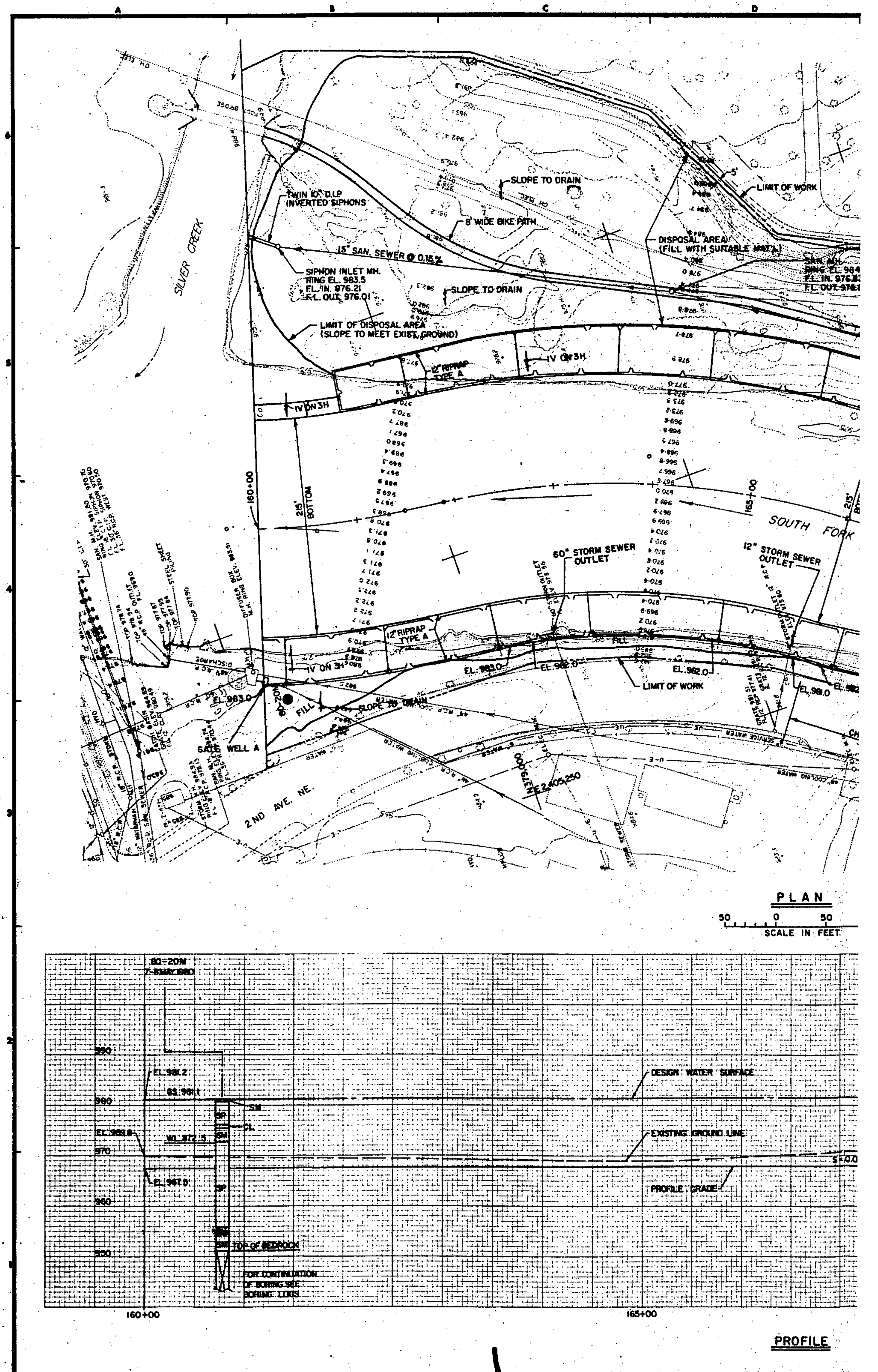
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: G.E.F. D.O.
DRAWN BY: G.E.N./K.R.R.
CHECKED BY: D.J.P./D.O.
SUBMITTED BY:

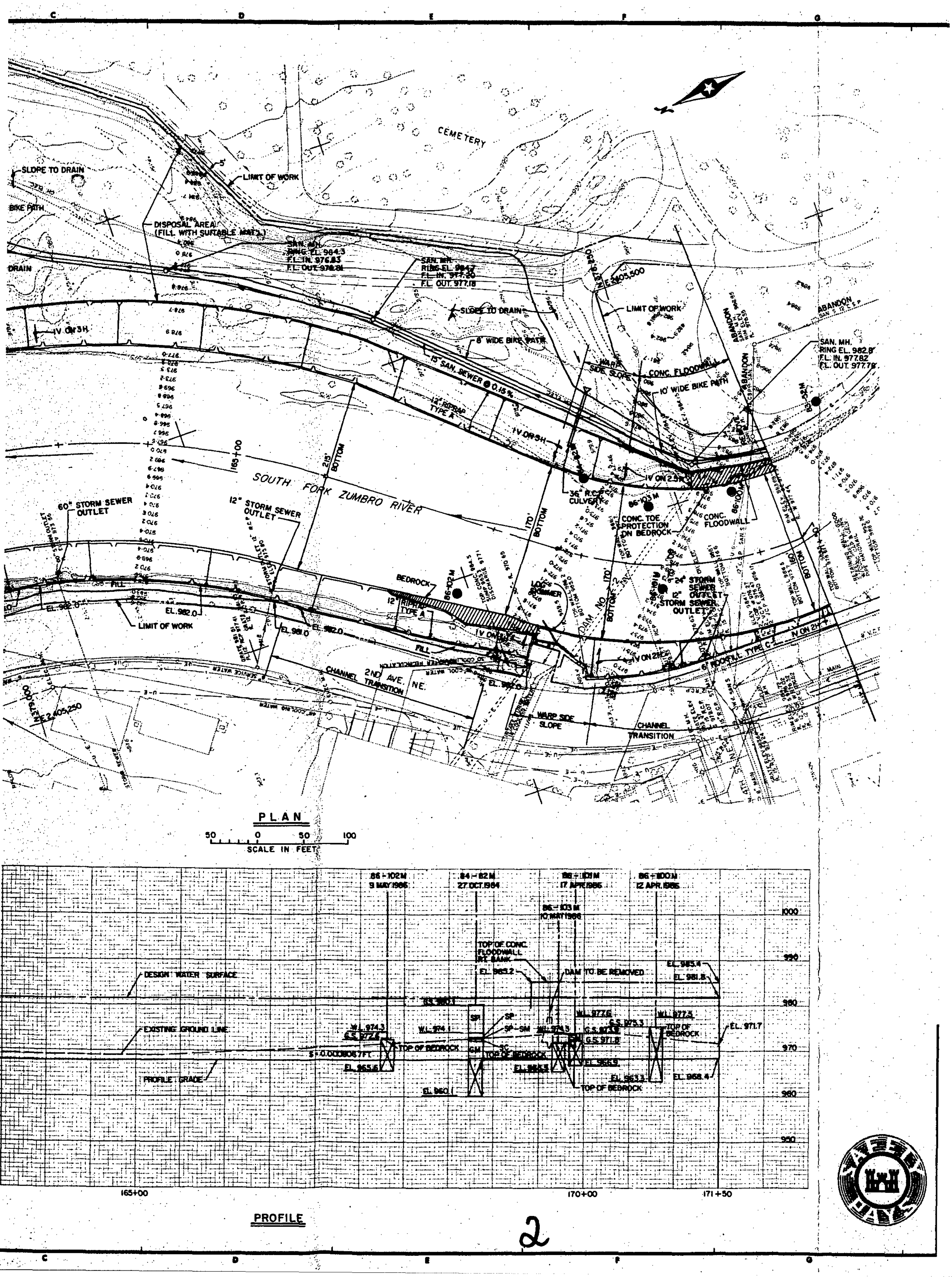
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
PLAN AND PROFILE
148+00 TO 160+00

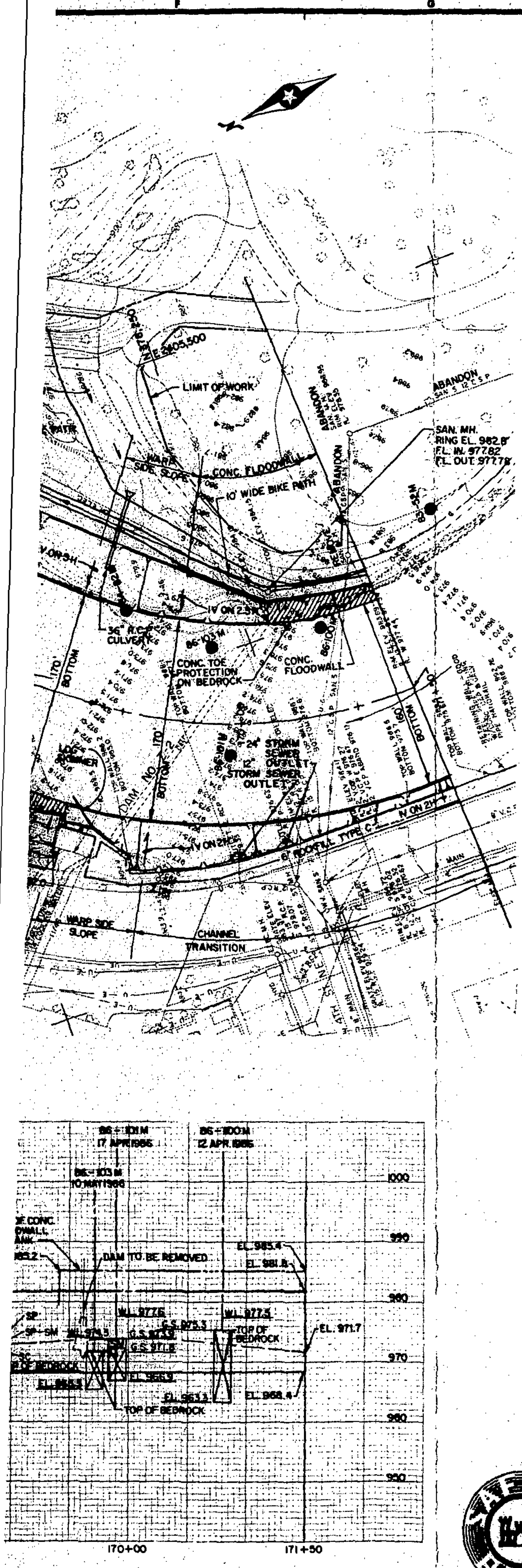
APPROVED BY:
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-64/7
SHEET 18 OF 45

PLATE 18



SILVER CREEK
TWIN 10" D.I.P. INVERTED SIPHONS
SLOPE TO DRAIN
8' WIDE BIKE PATH
LIMIT OF WORK
DISPOSAL AREA (FILL WITH SUITABLE MAT'L.)
15" SAN. SEWER @ 0.15%
SIPHON INLET MH. RING EL. 983.5 F.L. IN. 976.21 F.L. OUT 976.01
LIMIT OF DISPOSAL AREA (SLOPE TO MEET EXIST. GROUND)
12" RIPRAP TYPE A
IV ON 3H
160+00
215' BOTTOM
165+00
SOUTH FORK
60" STORM SEWER OUTLET
12" STORM SEWER OUTLET
EL. 983.0
EL. 982.0
EL. 981.0
FILL
SLOPE TO DRAIN
GATE WELL A
2 ND AVE. NE.
N 379,000
E 2,405,250
PLAN
SCALE IN FEET
80-20M
7-8 MAY 1980
EL. 981.2
EL. 969.8
EL. 967.5
DESIGN WATER SURFACE
EXISTING GROUND LINE
PROFILE GRADE
W.L. 972.5
TOP OF BEDROCK
FOR CONTINUATION OF BORING SEE BORING LOGS
160+00
165+00
PROFILE


CEMETERY
SLOPE TO DRAIN
BIKE PATH
LIMIT OF WORK
DISPOSAL AREA (FILL WITH SUITABLE MAT'L.)
SAN. MH. RING EL. 984.3 F.L. IN. 976.83 F.L. OUT. 976.81
SAN. MH. RING EL. 984.7 F.L. IN. 977.20 F.L. OUT. 977.18
SLOPE TO DRAIN
8' WIDE BIKE PATH
15" SAN. SEWER @ 0.15%
12" RIPRAP TYPE A
1V ON 3H
WARP SIDE SLOPE
CONC. FLOODWALL
10' WIDE BIKE PATH
ABANDON
SAN. MH. RING EL. 982.8 F.L. IN. 977.82 F.L. OUT. 977.78
N E 2,405,500
165+00
215' BOTTOM
SOUTH FORK ZUMBRO RIVER
60" STORM SEWER OUTLET
12" STORM SEWER OUTLET
36" R.C. CULVERT
1V ON 2.5H
86-103 M
86-100 M
CONC. TOE PROTECTION ON BEDROCK
CONC. FLOODWALL
170' BOTTOM
160' BOTTOM
BEDROCK
86-102 M
12" RIPRAP TYPE A
LOG SKIMMER
DAM NO. 2
24" STORM SEWER OUTLET
12" STORM SEWER OUTLET
EL. 982.0
LIMIT OF WORK
EL. 981.0
EL. 982.0
FILL
1V ON 2H
6" ROCKFILL TYPE C
2ND AVE. NE.
CHANNEL TRANSITION
EL. 982.0
WARP SIDE SLOPE
CHANNEL TRANSITION
N 2,405,250
PLAN
50 0 50 100
SCALE IN FEET
86+102M 9 MAY 1986
84+82M 27 OCT. 1984
86+101M 17 APR. 1986
86+100M 12 APR. 1986
86+103M 10 MAY 1986
TOP OF CONC. FLOODWALL RT. BANK
EL. 985.2
DAM TO BE REMOVED
EL. 985.4
EL. 981.8
DESIGN WATER SURFACE
EXISTING GROUND LINE
PROFILE GRADE
S=0.0008087 FT.
W.L. 974.3
G.S. 972.6
TOP OF BEDROCK
EL. 965.6
W.L. 974.1
SP
SP-SM
GM
SC
TOP OF BEDROCK
EL. 960.1
W.L. 974.3
EL. 965.5
W.L. 977.6
G.S. 975.3
G.S. 971.8
EL. 966.9
EL. 963.3
TOP OF BEDROCK
W.L. 977.5
TOP OF BEDROCK
EL. 971.7
EL. 968.4
1000
990
980
970
960
950
165+00
170+00
171+50
PROFILE
2



3

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: G.E.F./D.O.
DRAWN BY: G.E.N./K.R.R.
CHECKED BY: D.J.P./D.O.
SUBMITTED BY:

DESIGN MEMORANDUM NO.2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
PLAN AND PROFILE
160+00 TO 171+50

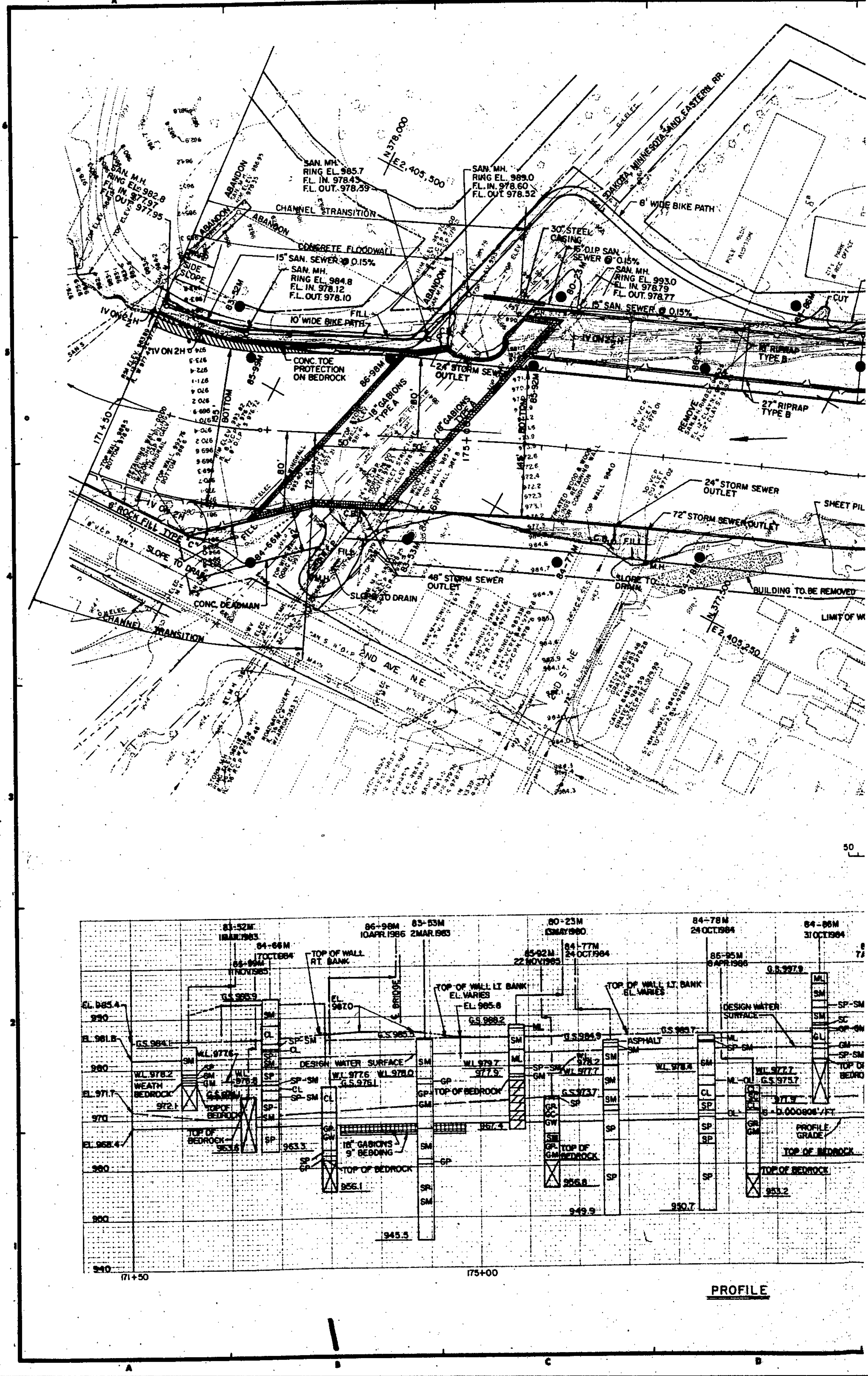
APPROVED BY:

DATE: DECEMBER 1986

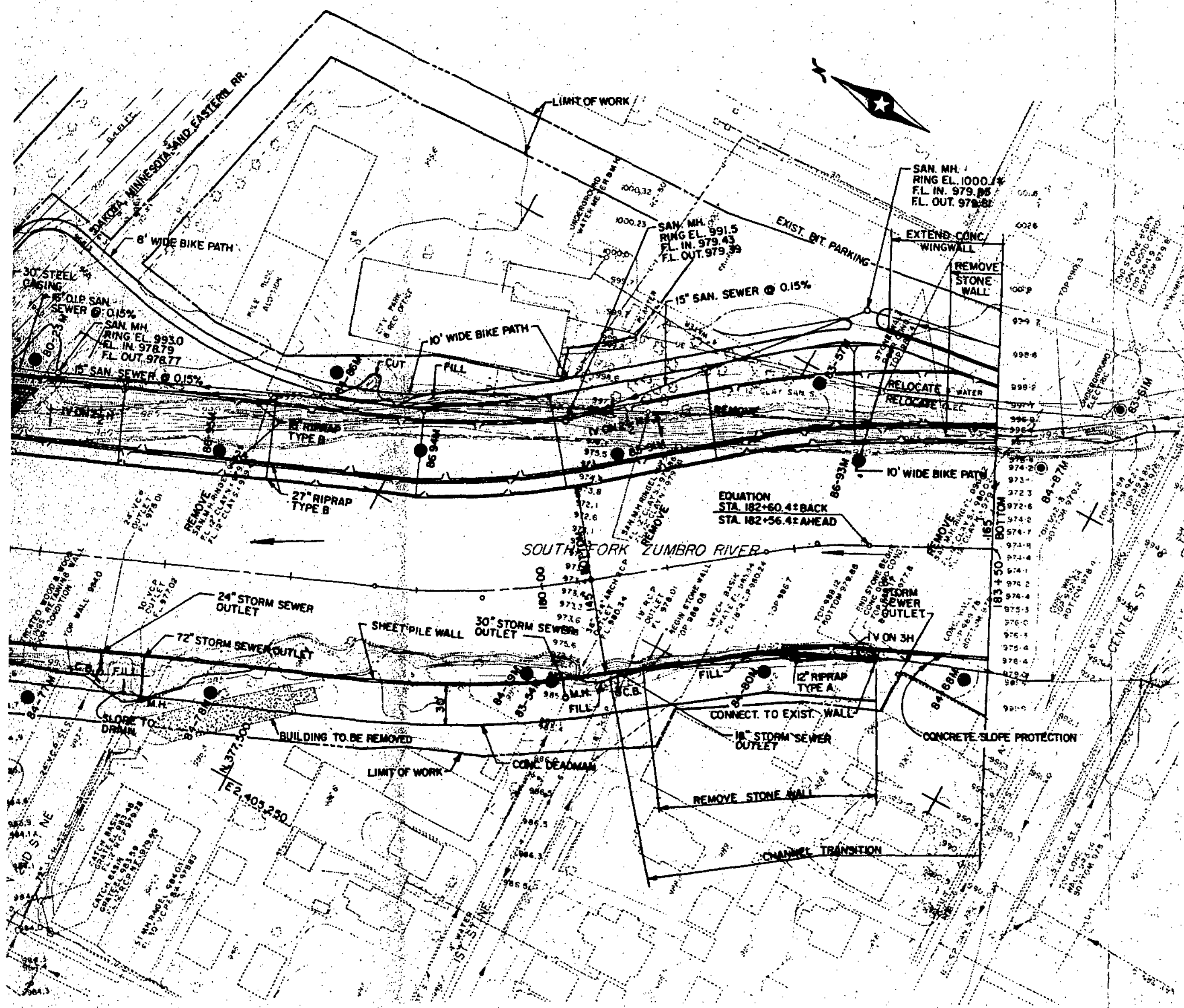
SCALE: AS SHOWN

DRAWING NUMBER: M30-R-64/8
SHEET 19 OF 45

PLATE 19

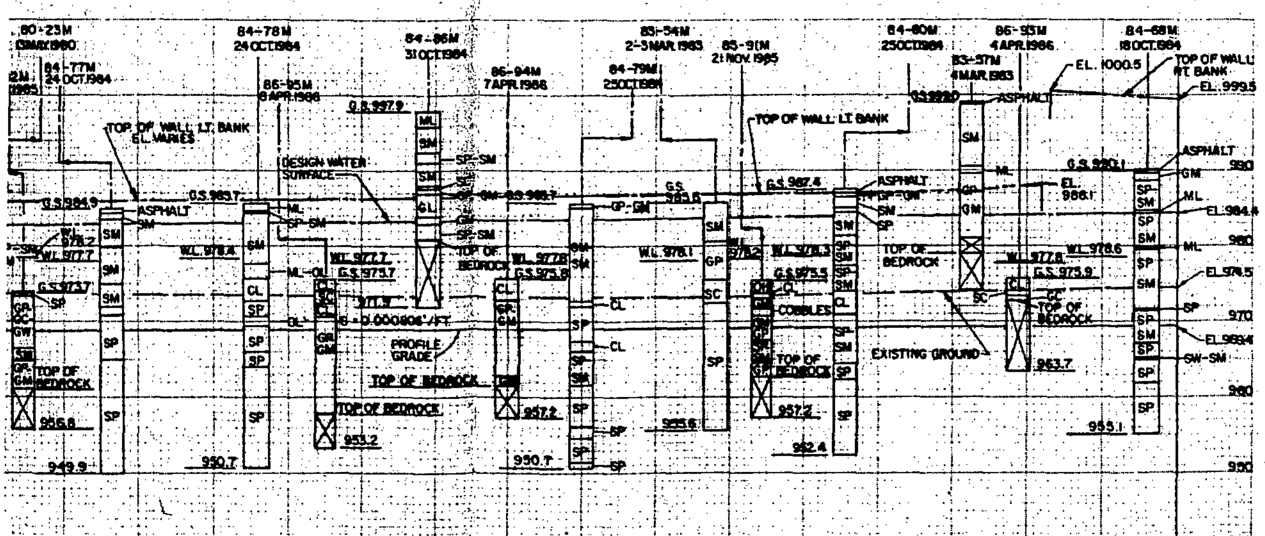


DAKOTA, MINNESOTA AND EASTERN RR.
8' WIDE BIKE PATH
N 378,000
E 2,405,500
SAN. MH.
RING EL. 985.7
F.L. IN. 978.43
F.L. OUT. 978.39
SAN. MH.
RING EL. 989.0
F.L. IN. 978.60
F.L. OUT. 978.52
CHANNEL TRANSITION
CONCRETE FLOODWALL
15" SAN. SEWER @ 0.15%
SAN. MH.
RING EL. 984.8
F.L. IN. 978.12
F.L. OUT. 978.10
30" STEEL CASING
SAN. MH.
RING EL. 993.0
F.L. IN. 978.79
F.L. OUT. 978.77
15" SAN. SEWER @ 0.15%
10' WIDE BIKE PATH
FILL
ABANDON
CONC. TOE PROTECTION ON BEDROCK
24" STORM SEWER OUTLET
18" GABIONS TYPE A
27" RIPRAP TYPE B
REMOVE
24" STORM SEWER OUTLET
72" STORM SEWER OUTLET
SHEET PIL
48" STORM SEWER OUTLET
SLOPE TO DRAIN
CONC. DEADMAN
CHANNEL TRANSITION
6" ROCK FILL TYPE C
BUILDING TO BE REMOVED
LIMIT OF W
N 377,500
E 2,405,250
2ND AVE. N.E.
2ND ST. NE
171+50
175+00
CUT
TOP OF WALL RT. BANK
TOP OF WALL LT. BANK EL. VARIES
DESIGN WATER SURFACE
18" GABIONS 9" BEDDING
TOP OF BEDROCK
WEATH BEDROCK
PROFILE GRADE
S = 0.000806'/FT
ASPHALT
EL. 985.4
EL. 981.8
EL. 971.7
EL. 968.4
PROFILE



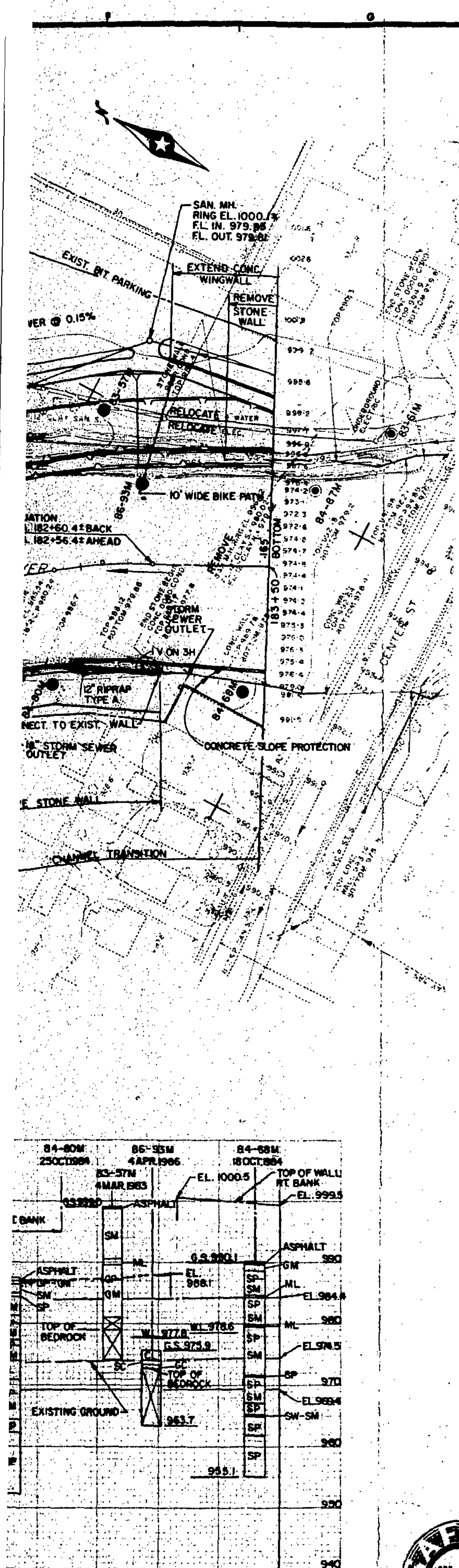
PLAN

50 0 50 100
SCALE IN FEET



PROFILE

2



3

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

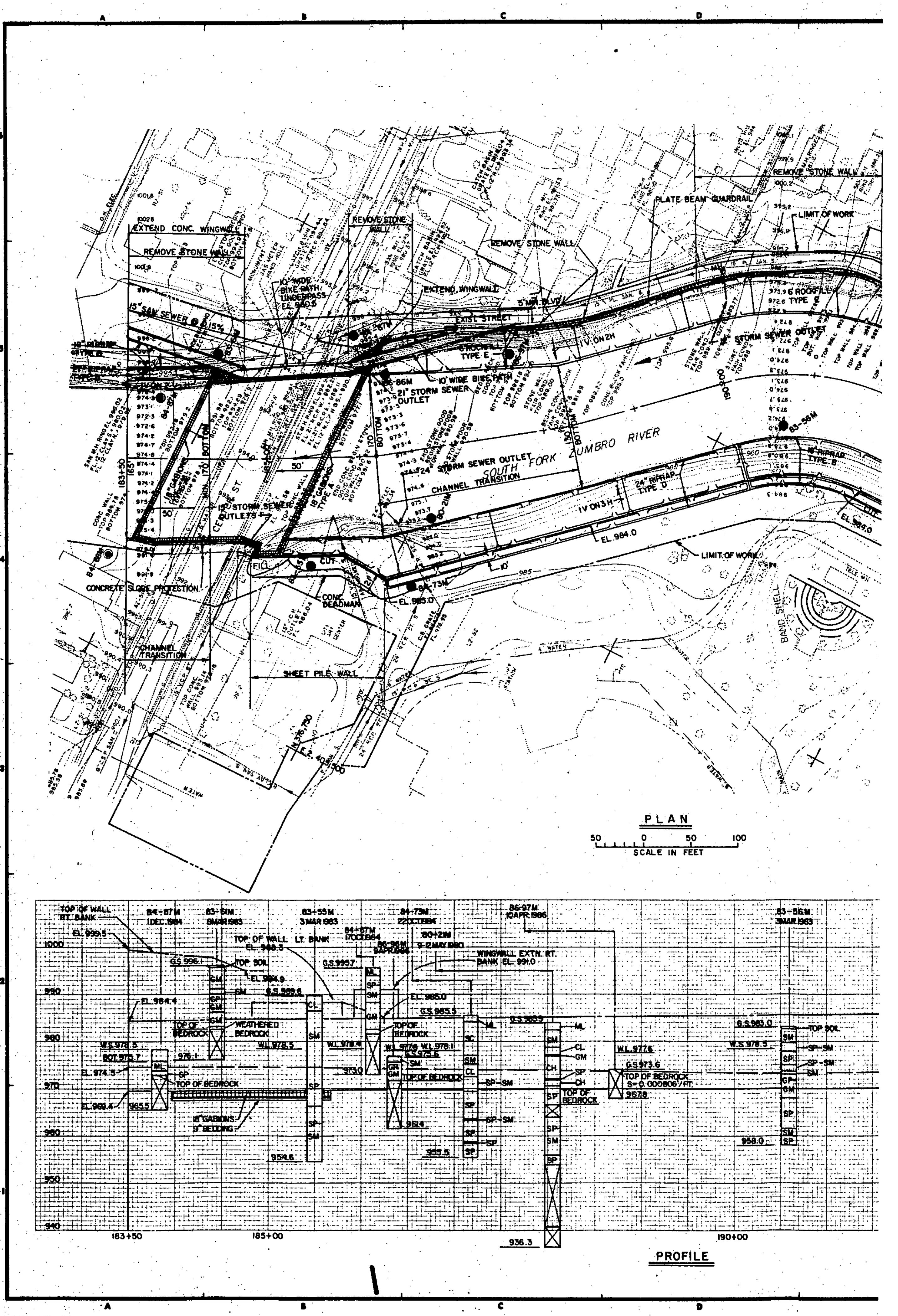
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: G.E.F./D.O.
DRAWN BY: G.E.N./K.R.R.
CHECKED BY: D.J.P./D.O.
SUBMITTED BY:

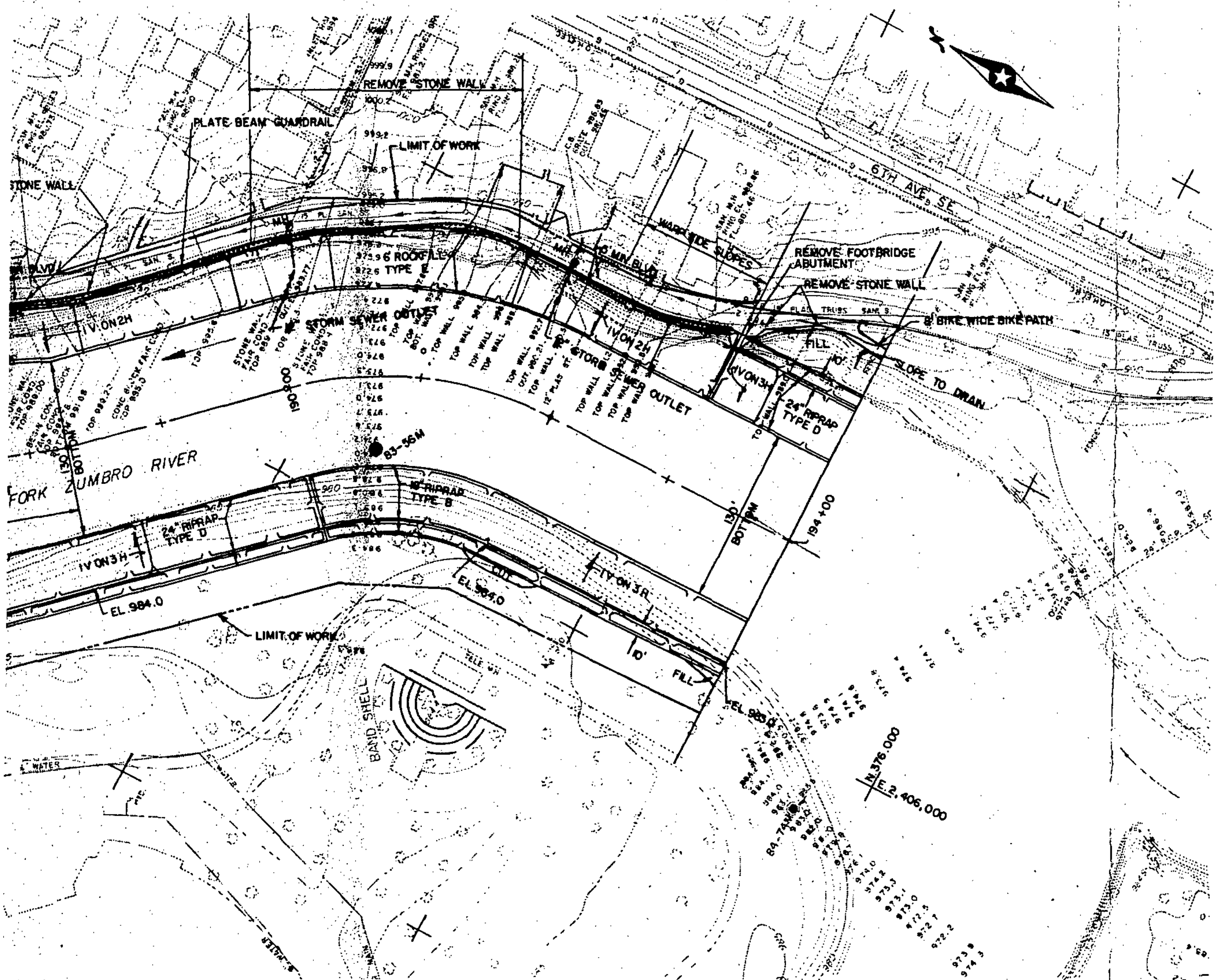
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
PLAN AND PROFILE
171+50 TO 183+50

APPROVED BY:
DATE: DECEMBER 1986
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER: M30-R-64/9
SHEET 20 OF 45

PLATE 20

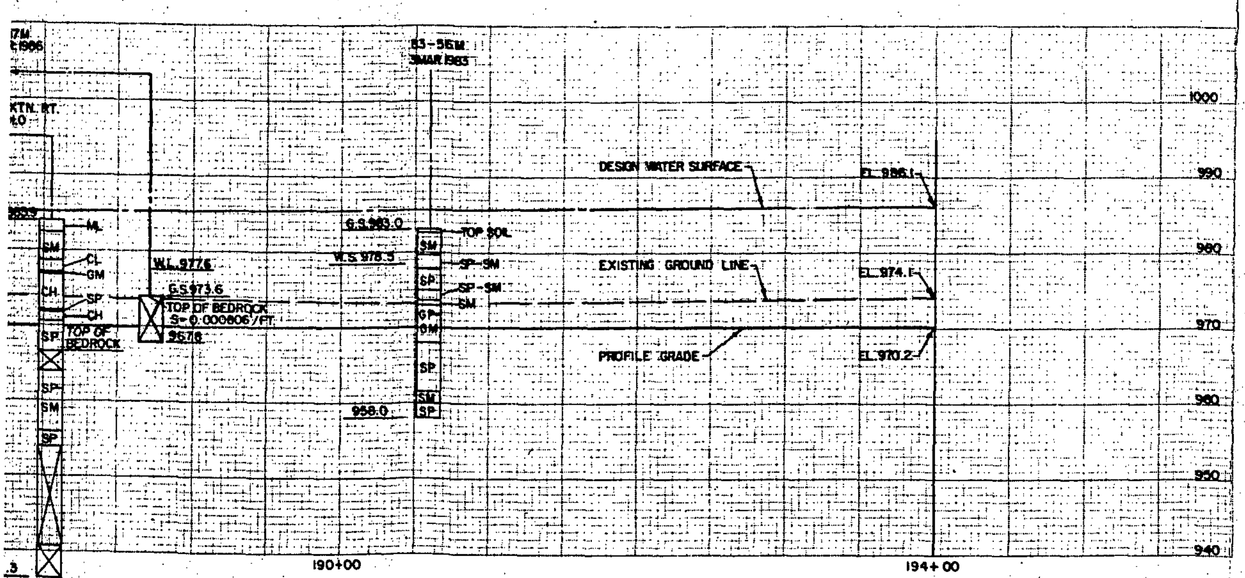


A
B
C
D
EXTEND CONC. WINGWALL
REMOVE STONE WALL
REMOVE STONE WALL
10' WIDE BIKE PATH UNDERPASS
EXTEND WINGWALL
REMOVE STONE WALL
PLATE BEAM GUARDRAIL
LIMIT OF WORK
EXIST. STREET
15" SAN. SEWER
21" STORM SEWER OUTLET
10' WIDE BIKE PATH
STORM SEWER OUTLET
1V ON 2H
SOUTH FORK ZUMBRO RIVER
24" STORM SEWER OUTLET
CHANNEL TRANSITION
24" RIPRAP TYPE D
1V ON 3H
EL. 984.0
LIMIT OF WORK
12" STORM SEWER OUTLETS
CONCRETE SLOPE PROTECTION
CONC. DEADMAN
EL. 985.0
CHANNEL TRANSITION
SHEET PILE WALL
BAND SHELL
PLAN
50
0
50
100
SCALE IN FEET
TOP OF WALL RT. BANK
EL. 999.5
TOP OF WALL LT. BANK
WINGWALL EXTN. RT. BANK EL. 991.0
TOP SOIL
EL. 984.4
TOP OF BEDROCK
WEATHERED BEDROCK
TOP OF BEDROCK
18" GABIONS
9" BEDDING
TOP OF ROCK
TOP OF BEDROCK
S= 0.000806'/FT.
TOP SOIL
1000
990
980
970
960
950
940
183+50
185+00
190+00
936.3
PROFILE



PLAN

50 0 50 100
SCALE IN FEET



PROFILE

2

SYMBOL	

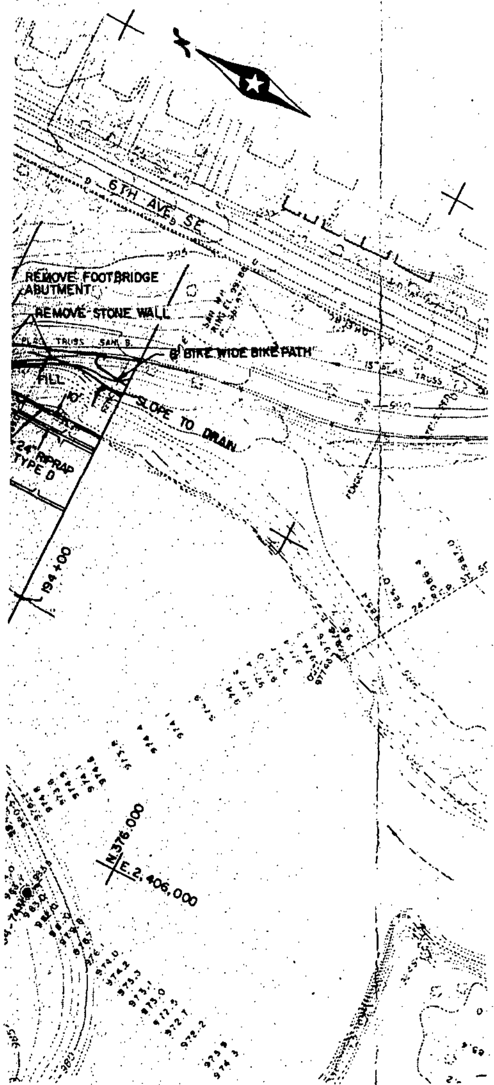
WHKS – Profession
Mason City, Ia. – R

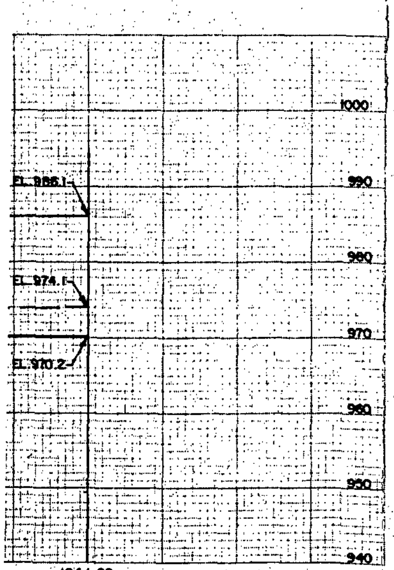
DESIGNED BY: G.E.F. D.O.

DRAWN BY: G.E.N./K.

CHECKED BY: D.J.P./D.

SUBMITTED BY:





SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

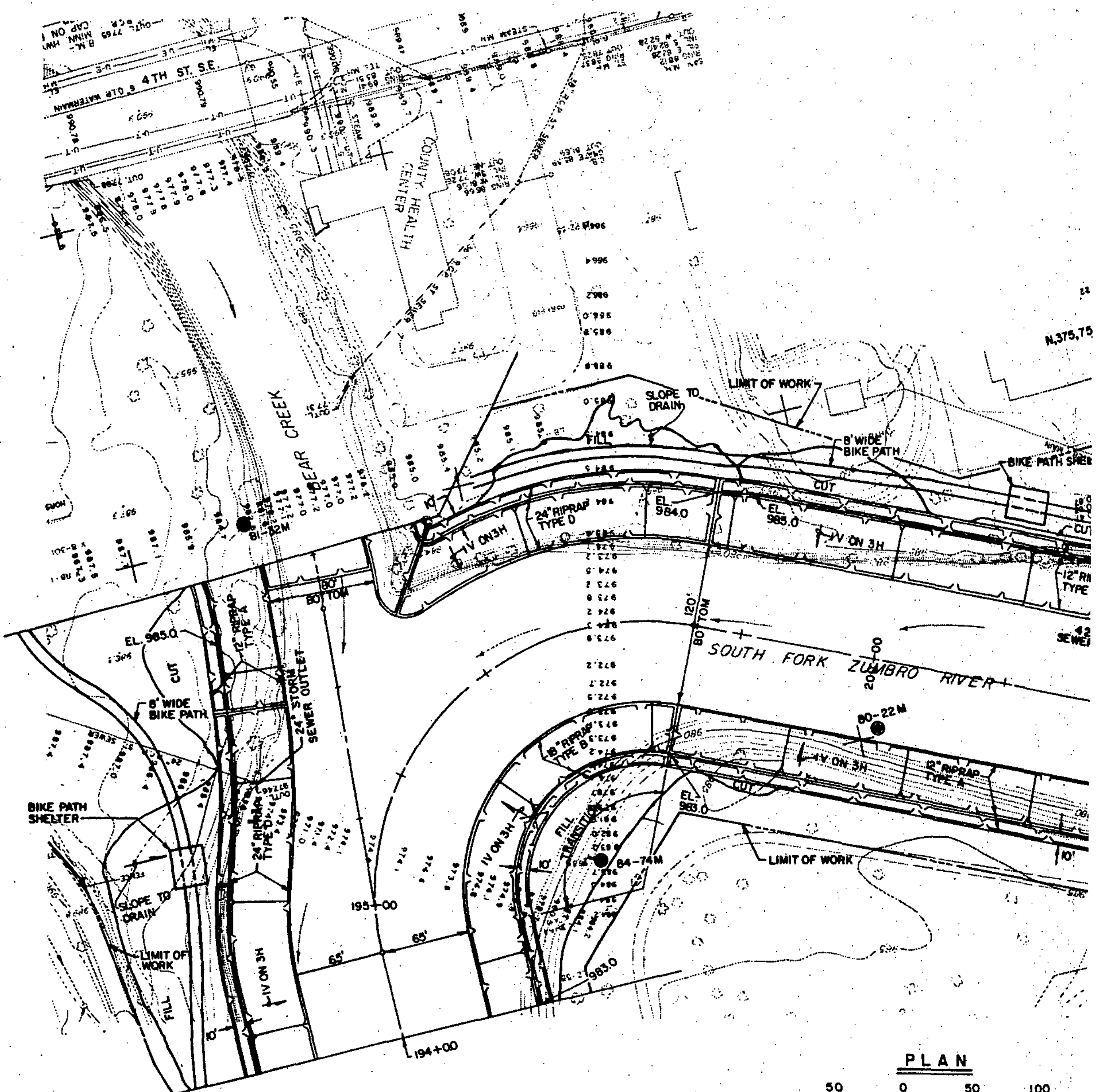
DESIGNED BY: G.E.F. / D.O.
DRAWN BY: G.E.N./K.R.R.
CHECKED BY: D.J.P./ D.O.
SUBMITTED BY:
APPROVED BY:

DESIGN MEMORANDUM NO.2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
PLAN AND PROFILE
183+50 TO 194+00

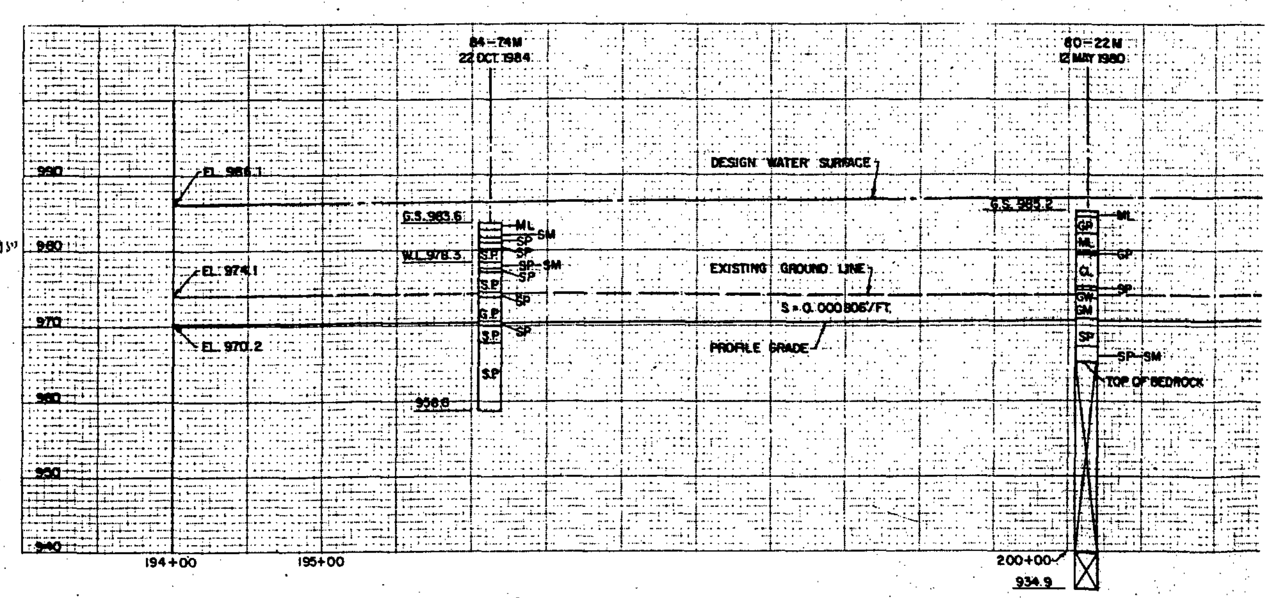
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-64/10
SHEET 21 OF 45

3

PLATE 21

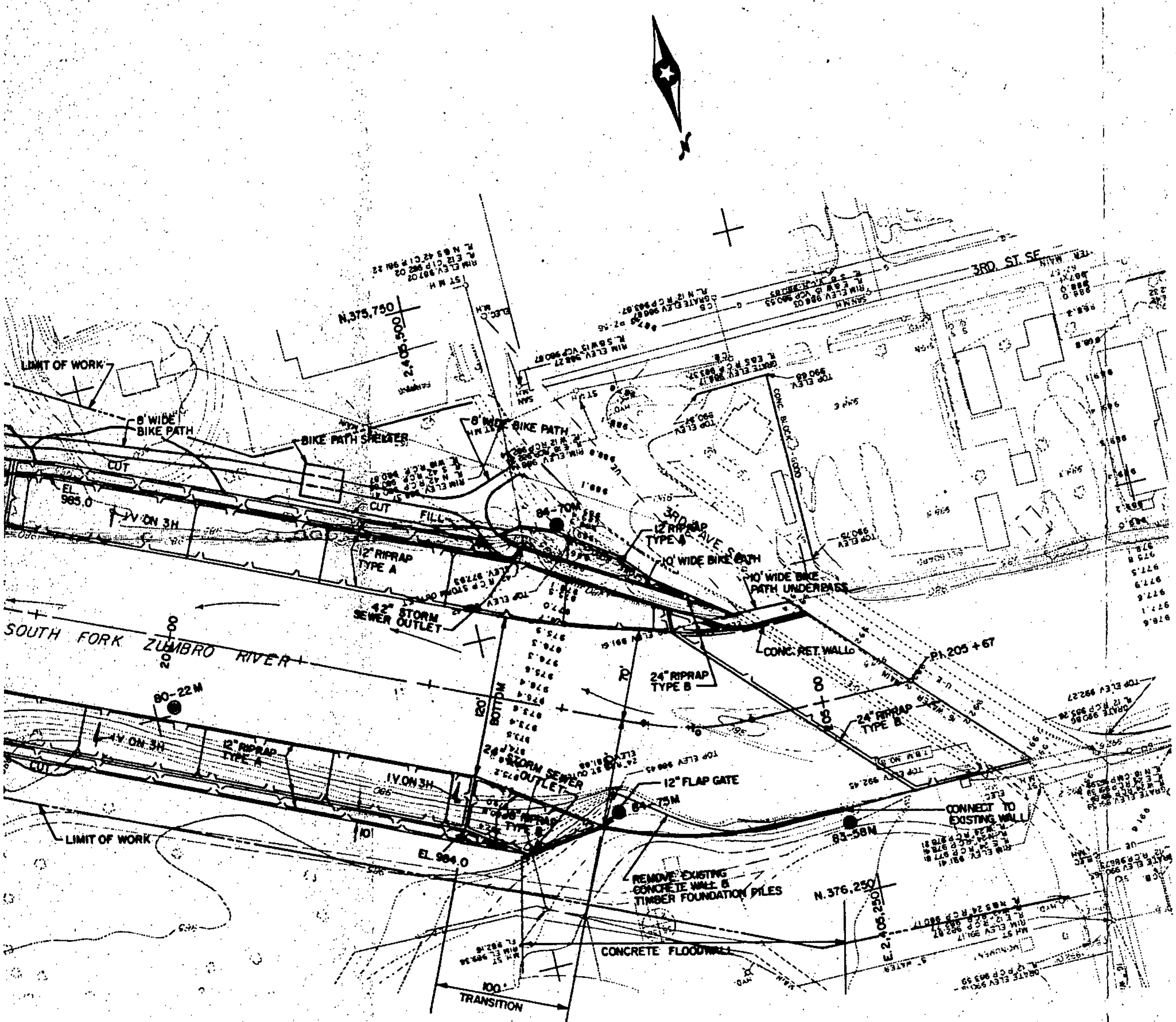


4TH ST. S.E.
COUNTY HEALTH CENTER
BEAR CREEK
SLOPE TO DRAIN
LIMIT OF WORK
8' WIDE BIKE PATH
BIKE PATH SHELTER
CUT
FILL
24" RIPRAP TYPE D
12" RIPRAP TYPE A
18" RIPRAP TYPE B
1V ON 3H
EL. 984.0
EL. 985.0
EL. 983.0
80' BOTTOM
120'
SOUTH FORK ZUMBRO RIVER
24" STORM SEWER OUTLET
81-82M
80-22M
84-74M
195+00
194+00
200+00
65'
10'
983.0
N.375,75
PLAN
50 0 50 100
SCALE IN FEET



84-74M
22 OCT. 1984
80-22M
12 MAY 1980
DESIGN WATER SURFACE
EL. 986.1
G.S. 983.6
G.S. 985.2
W.L. 978.3
EXISTING GROUND LINE
EL. 974.1
S = 0.000806'/FT.
EL. 970.2
PROFILE GRADE
958.6
TOP OF BEDROCK
ML
SP-SM
SP
GP
CL
GW
GM
990
980
970
960
950
940
194+00
195+00
200+00
934.9

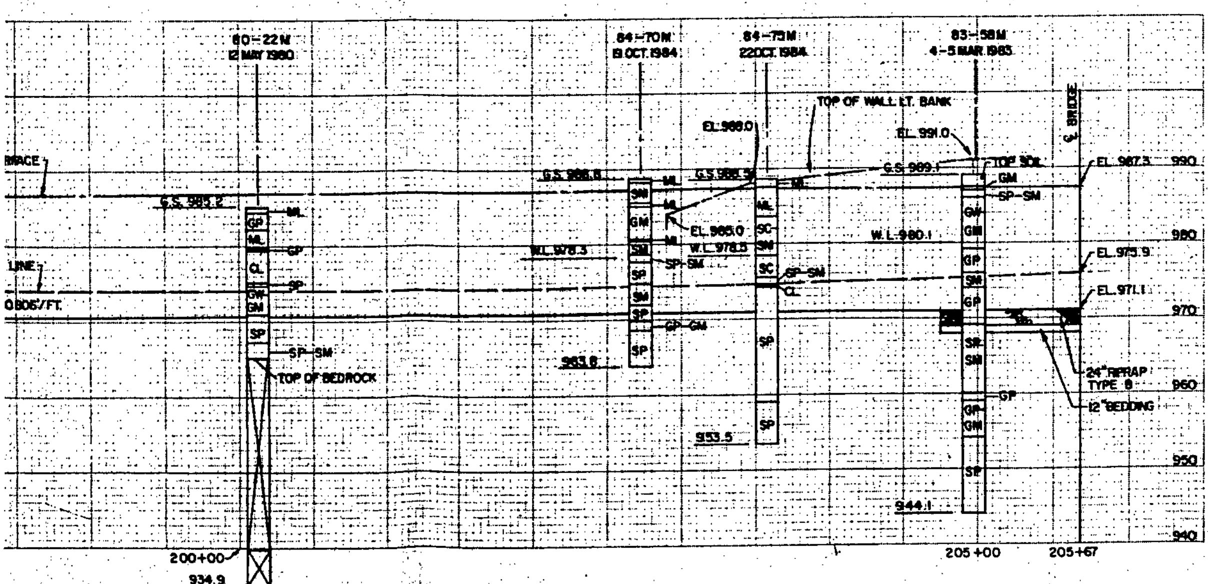
PROFILE



PLAN

50 0 50 100
SCALE IN FEET

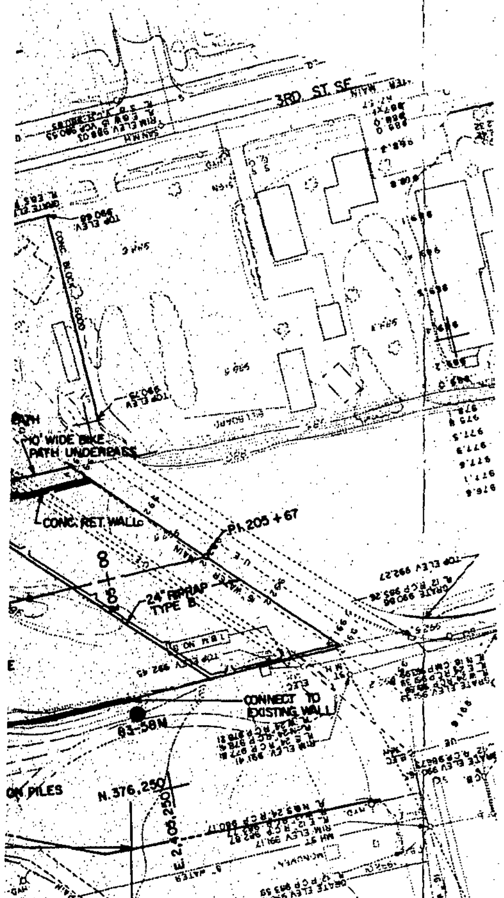
NOTE:
THE CITY OF ROCHESTER IS PLANNING (AS OF NOV. 24, 1986) TO REPLACE THE 3RD AVE BRIDGE, THEREFORE THE FINAL PLAN FOR THE BRIDGE AREA WILL BE REVISED.



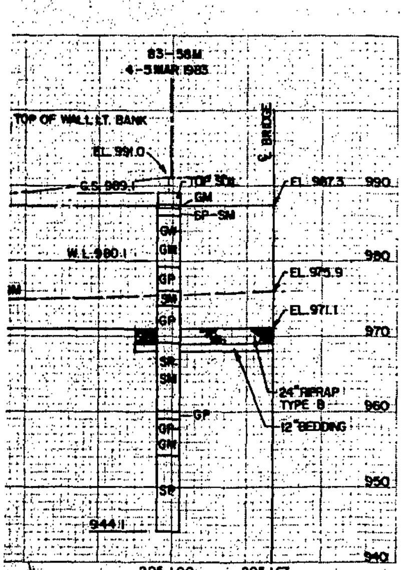
PROFILE

2

SYMBOL	
WHKS – Professional E[…] Mason City, Ia. – Roche[…]	
DESIGNED BY:	G.E.F. D.O.
DRAWN BY:	G.E.N./K.R.[…]
CHECKED BY:	D.J.P./D.O.
SUBMITTED BY:	



NOTE:
THE CITY OF ROCHESTER IS PLANNING (AS OF NOV. 24, 1986) TO REPLACE THE 3RD AVE BRIDGE, THEREFORE THE FINAL PLAN FOR THE BRIDGE AREA WILL BE REVISED.



3

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

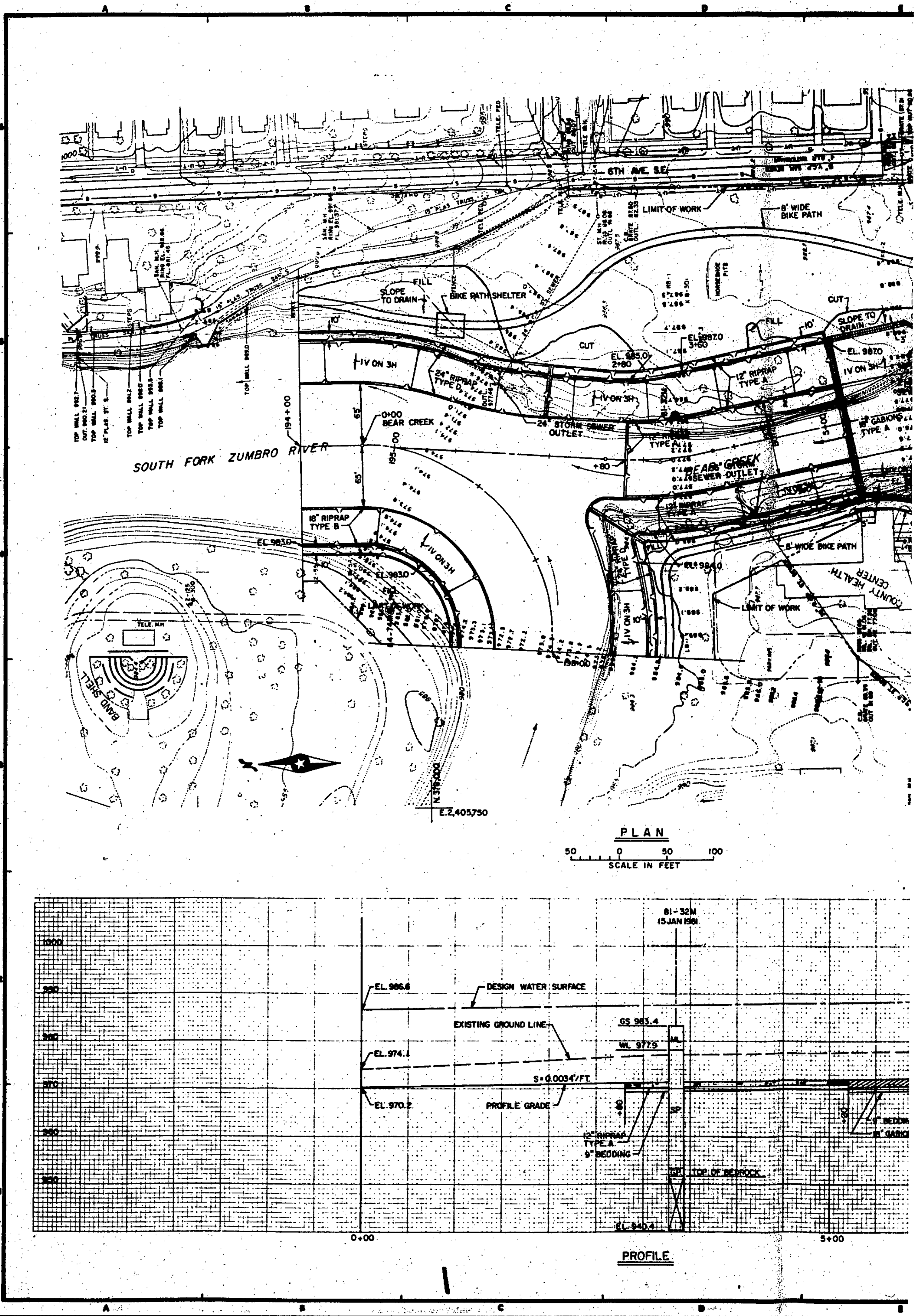
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: G.E.F. / D.O.
DRAWN BY: G.E.N./K.R.R.
CHECKED BY: D.J.P./D.O.
SUBMITTED BY:
APPROVED BY:

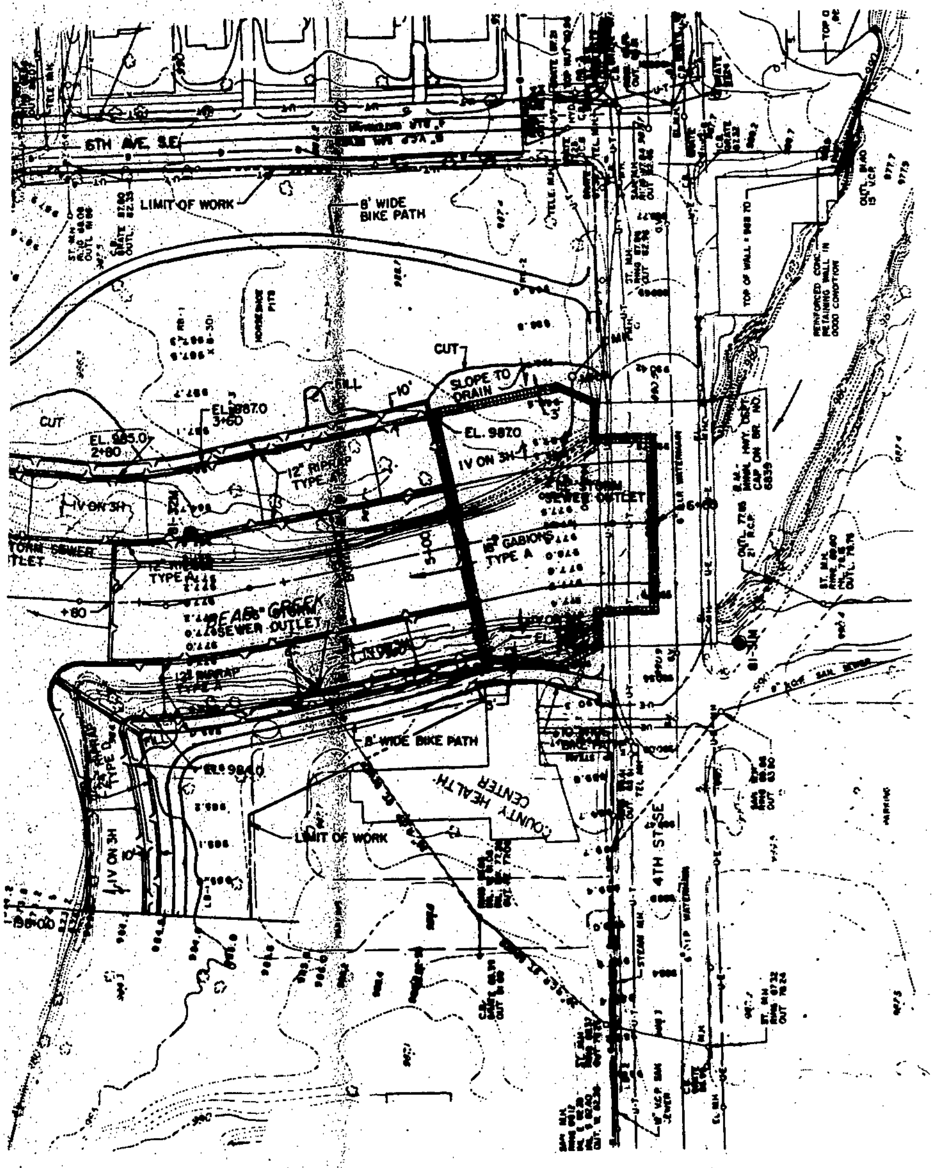
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
PLAN AND PROFILE
194+00 TO 205+67

DATE: DECEMBER 1986
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER M30-R-64/11
SHEET 22 OF 45

PLATE 22

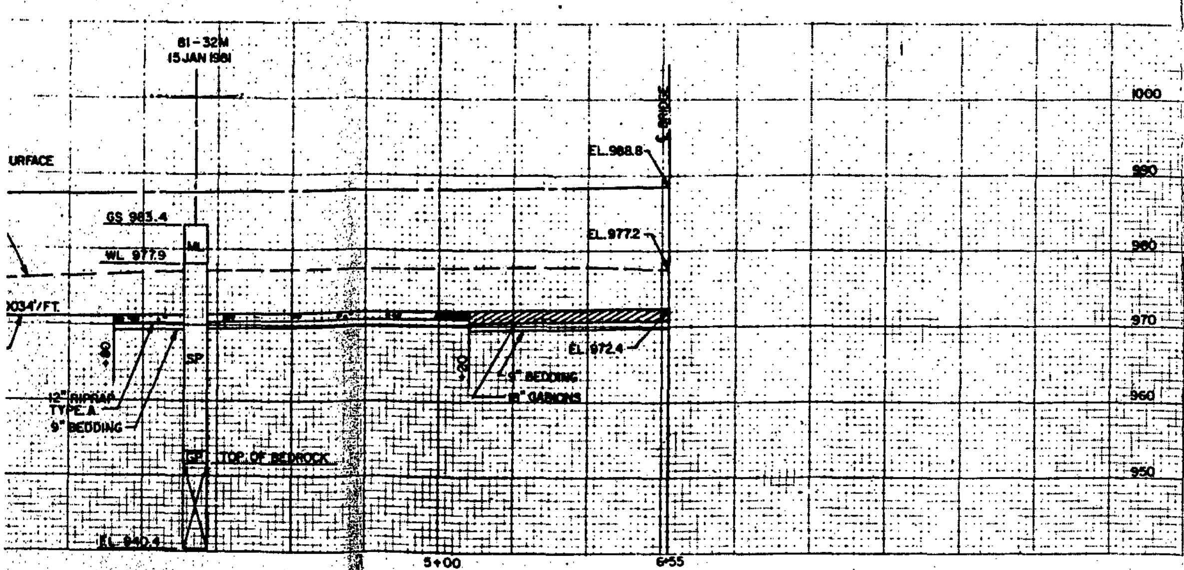


6TH AVE. S.E.
LIMIT OF WORK
8' WIDE BIKE PATH
SLOPE TO DRAIN
FILL
BIKE PATH SHELTER
CUT
EL. 987.0 3+60
EL. 985.0 2+80
12" RIPRAP TYPE A
EL. 987.0
1V ON 3H
24" RIPRAP TYPE D
24" STORM SEWER OUTLET
0+00 BEAR CREEK
194+00
195+00
SOUTH FORK ZUMBRO RIVER
BEAR CREEK
SEWER OUTLET
18" GABIONS TYPE A
18" RIPRAP TYPE B
EL. 983.0
EL. 984.0
8' WIDE BIKE PATH
COUNTY HEALTH CENTER
BAND SHELL
TELE. MH
196+00
N.376,000
E.2,405,750
PLAN
SCALE IN FEET
50 0 50 100
81-32M 15 JAN 1981
1000
990
980
970
960
950
EL. 986.6
DESIGN WATER SURFACE
EXISTING GROUND LINE
GS 983.4
WL 977.9
EL. 974.1
S = 0.0034'/FT.
EL. 970.2
PROFILE GRADE
12" RIPRAP TYPE A
9" BEDDING
SP
TOP OF BEDROCK
EL. 940.4
0+00
5+00
PROFILE



PLAN

50 0 50 100
SCALE IN FEET



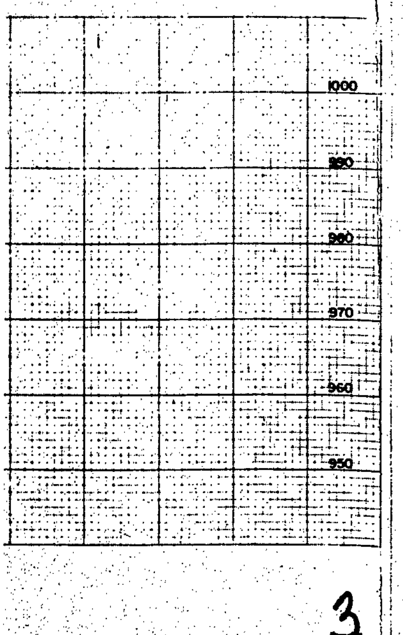
PROFILE

SYMBOL

WHKS – Professional Engin
Mason City, Ia. – Rochester,

DESIGNED BY: D.O.
DRAWN BY: K.R.R
CHECKED BY: D.O.
SUBMITTED BY:

2



SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: D.O.
DRAWN BY: K.R.R
CHECKED BY: D.O.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
PLAN AND PROFILE
0+00 TO 6+55 (BEAR CREEK)

APPROVED BY:

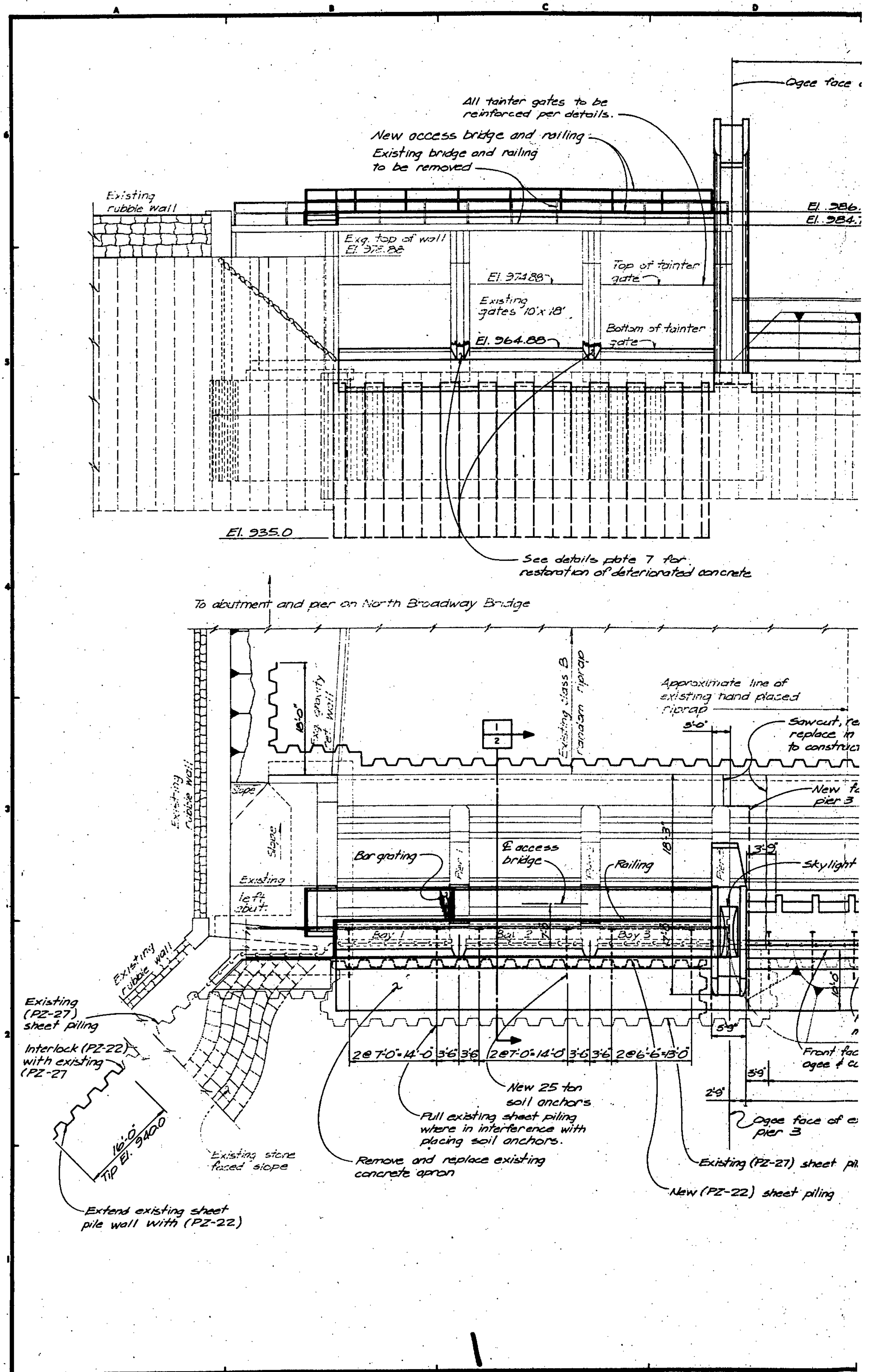
DATE: DECEMBER 1986

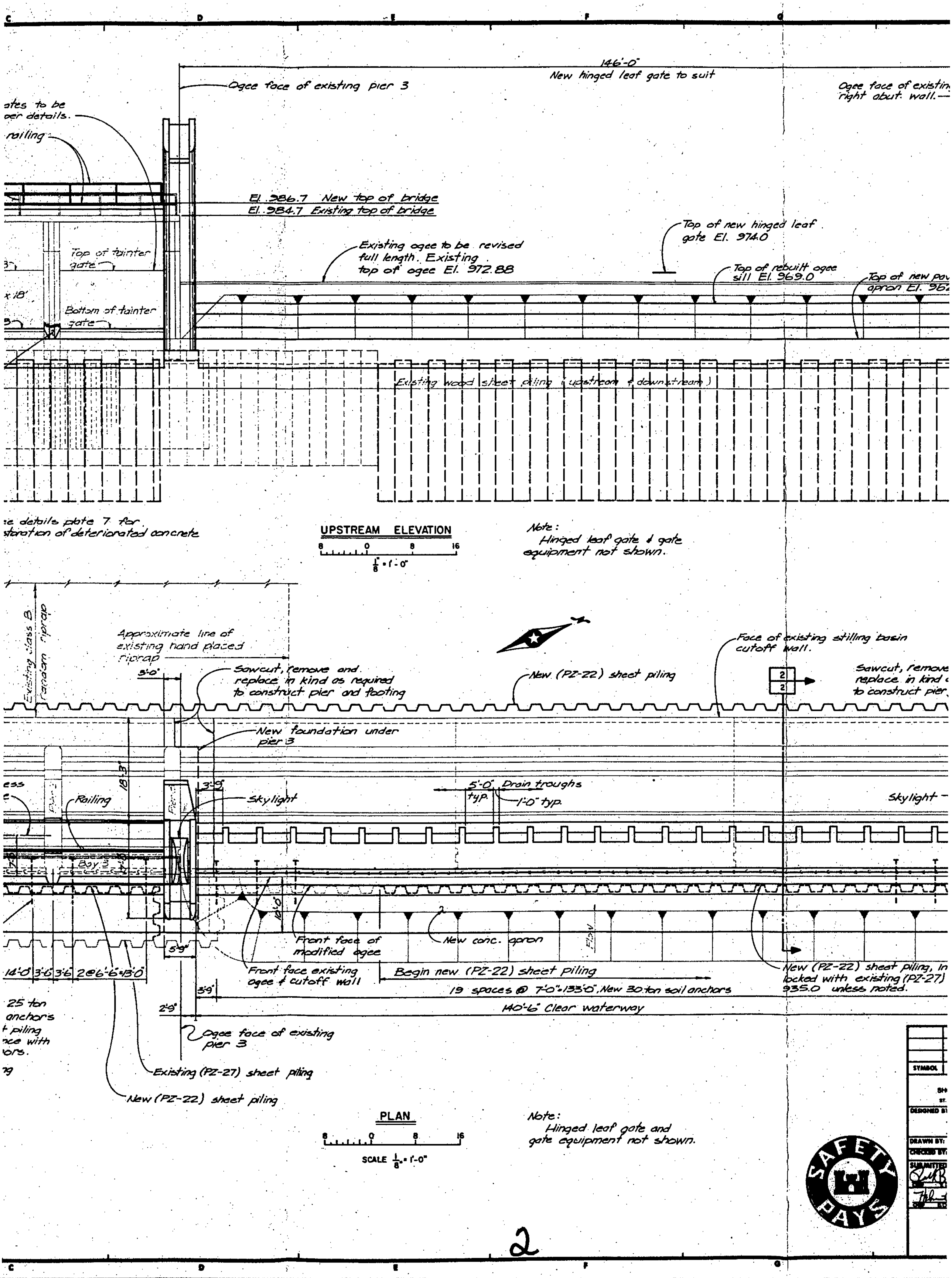
SCALE: AS SHOWN

DRAWING NUMBER: M30-R-64/12

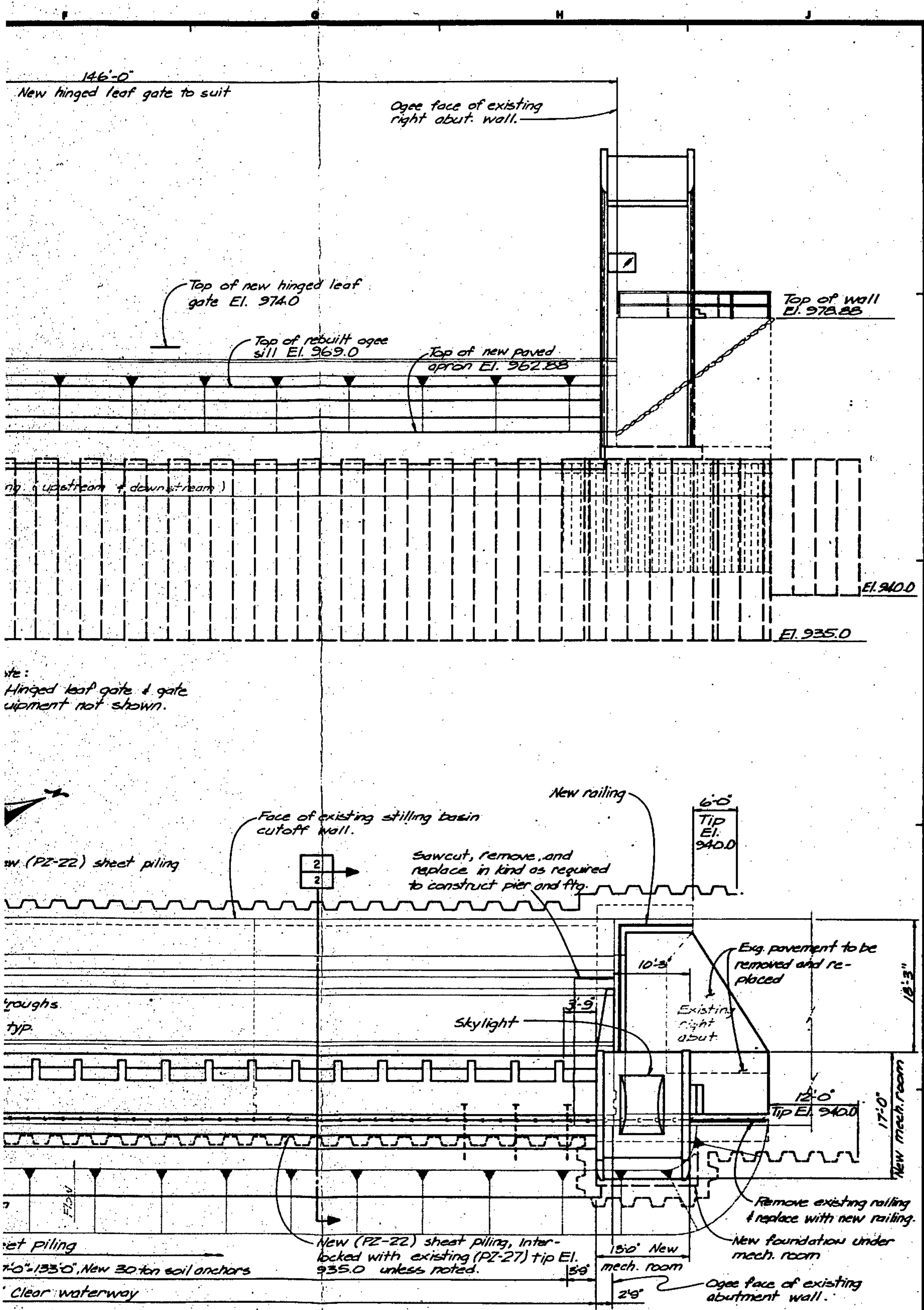
SHEET 23 OF 45

3


All tainter gates to be reinforced per details.
New access bridge and railing
Existing bridge and railing to be removed
Existing rubble wall
Exg. top of wall El. 978.88
El. 974.88
Existing gates 10'x 18'
El. 964.88
Top of tainter gate
Bottom of tainter gate
Ogee face
El. 935.0
See details plate 7 for restoration of deteriorated concrete
To abutment and pier on North Broadway Bridge
Approximate line of existing hand placed riprap
Existing class B random riprap
Exg. gravity left wall
Existing rubble wall
Slope
Existing left abut.
Bar grating
℄ access bridge
Railing
Skylight
Pier 1
Pier 3
Bay 1
Bay 2
Bay 3
New 25 ton soil anchors
Pull existing sheet piling where in interference with placing soil anchors.
Remove and replace existing concrete apron
Existing stone faced slope
Existing (PZ-27) sheet piling
Interlock (PZ-22) with existing (PZ-27)
Extend existing sheet pile wall with (PZ-22)
16'-0" Tip El. 940.0
2@7'-0"=14'-0" 3'-6" 3'-6" 2@7'-0"=14'-0" 3'-6" 3'-6" 2@6'-6"=13'-0"
Ogee face of existing pier 3
Existing (PZ-27) sheet piling
New (PZ-22) sheet piling
Front face of ogee



146'-0"
New hinged leaf gate to suit
Ogee face of existing pier 3
Ogee face of existin right abut. wall.
ates to be
oer details.
railing
El. 986.7 New top of bridge
El. 984.7 Existing top of bridge
Top of new hinged leaf gate El. 974.0
Existing ogee to be revised full length. Existing top of ogee El. 972.88
Top of tainter gate
Bottom of tainter gate
Top of rebuilt ogee sill El. 969.0
Top of new pav apron El. 96
Existing wood sheet piling (upstream & downstream)
e details plate 7 for
storation of deteriorated concrete
UPSTREAM ELEVATION
8 0 8 16
1/8" = 1'-0"
Note:
Hinged leaf gate & gate equipment not shown.
Existing class B random riprap
Approximate line of existing hand placed riprap
3'-0"
Sawcut, remove and replace in kind as required to construct pier and footing
New (PZ-22) sheet piling
Face of existing stilling basin cutoff wall.
Sawcut, remove replace in kind to construct pier
New foundation under pier 3
18'-3"
3'-9"
Railing
Skylight
5'-0" typ.
Drain troughs
1'-0" typ.
Skylight
Bay 3
10'-0"
5'-9"
Front face of modified ogee
New conc. apron
Flow
14'-0 3'-6 3'-6 2@6'-6 3'-0
Front face existing ogee & cutoff wall
Begin new (PZ-22) sheet piling
New (PZ-22) sheet piling, in locked with existing (PZ-27) 935.0 unless noted.
3'-9"
19 spaces @ 7'-0"=133'-0". New 30 ton soil anchors
2'-9"
140'-6" Clear waterway
25 ton anchors
piling
nce with
ors.
Ogee face of existing pier 3
Existing (PZ-27) sheet piling
New (PZ-22) sheet piling
PLAN
8 0 8 16
SCALE 1/8" = 1'-0"
Note:
Hinged leaf gate and gate equipment not shown.
SYMBOL
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED
SAFETY PAYS
2



ote:
Hinged leaf gate and gate equipment not shown.

SYMBOL	DESCRIPTION	DATE	APPROVAL

PREPARED BY SHORT ELLIOTT HENDRICKSON, INC. ST. PAUL, MINNESOTA & CHIPPEWA FALLS, WISC.

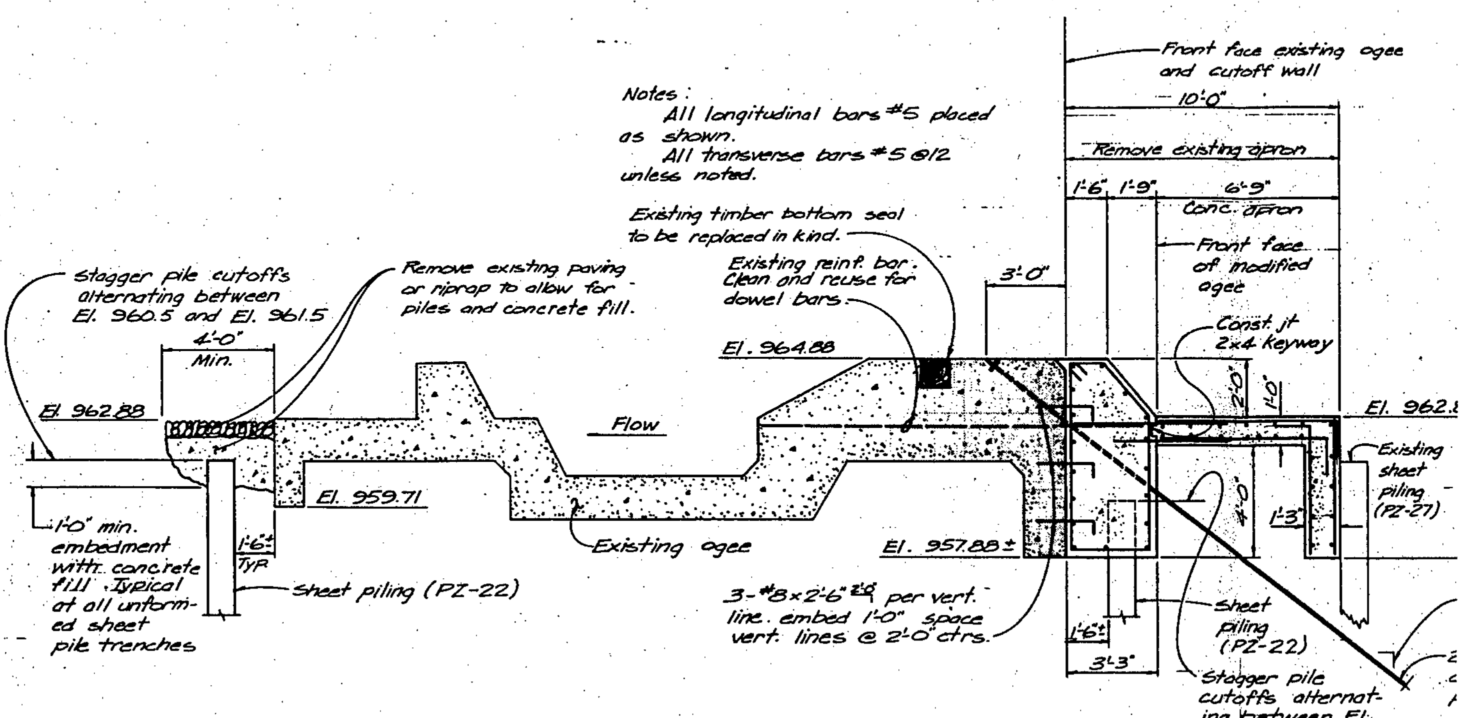
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: T.C.B.
DRAWN BY: D.L.F./J.L.P.
CHECKED BY: J.L.P./T.C.B.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 — FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM
PLAN AND UPSTREAM ELEVATION

APPROVED BY:
DATE: JUNE 1985
SCALE: AS SHOWN
DRAWING NUMBER M30-R-40/1
SHEET 24 OF 45

3



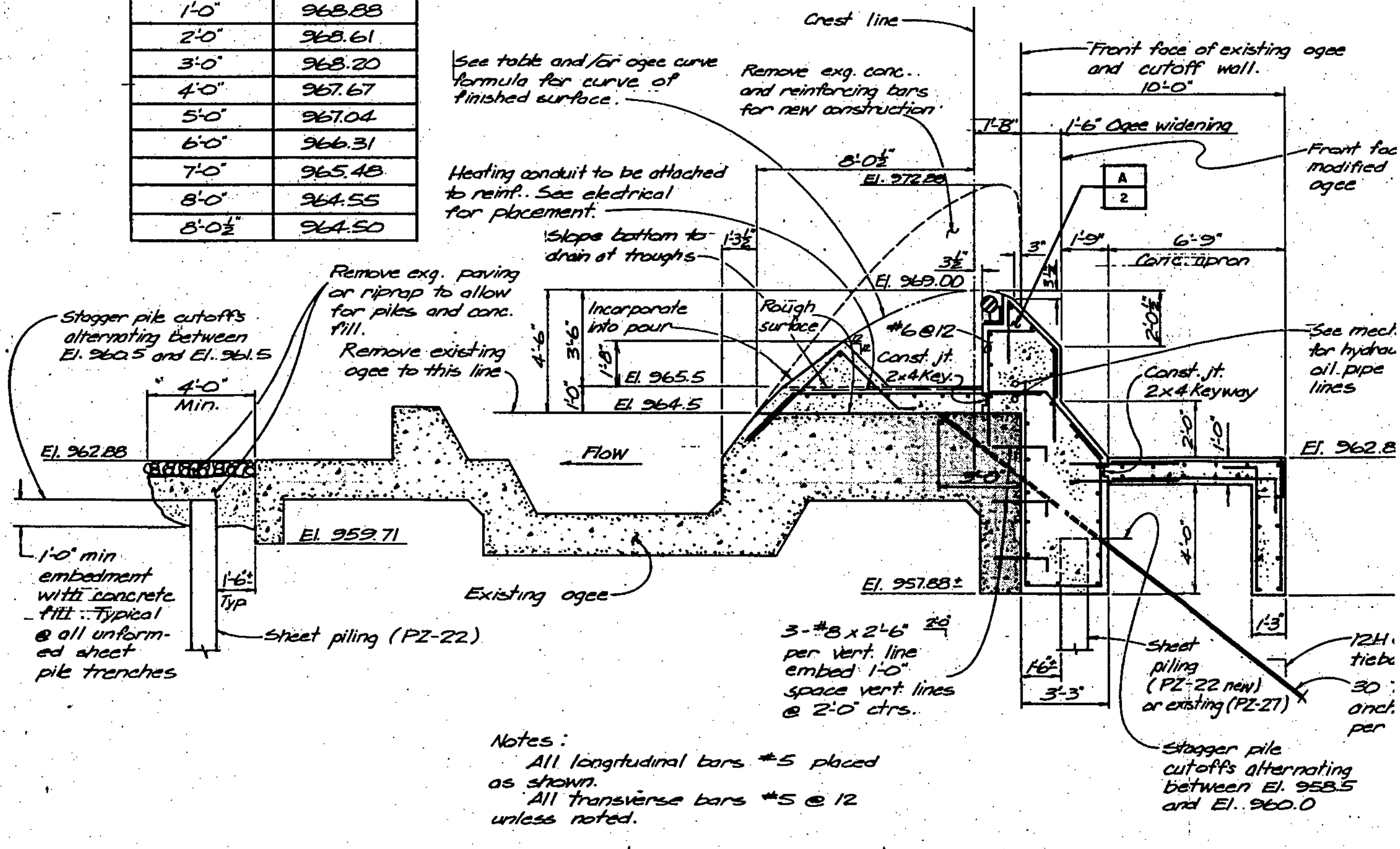
SECTION 1 / 1

$\frac{3}{8}" = 1'-0"$

Curve of Finished Surface of New Hinged Leaf Gate	
Distance Dnstr. from Crest Line	Elevation
0'-0 Crest line	969.00
1'-0"	968.88
2'-0"	968.61
3'-0"	968.20
4'-0"	967.67
5'-0"	967.04
6'-0"	966.31
7'-0"	965.48
8'-0"	964.55
8'-0½"	964.50

Ogee Curve Formula

$$\frac{Y}{7.5} = -.53\left(\frac{x}{7.5}\right)^{1.747}$$



Notes:
All longitudinal bars #5 placed as shown.
All transverse bars #5 @ 12 unless noted.

SECTION 2 / 1

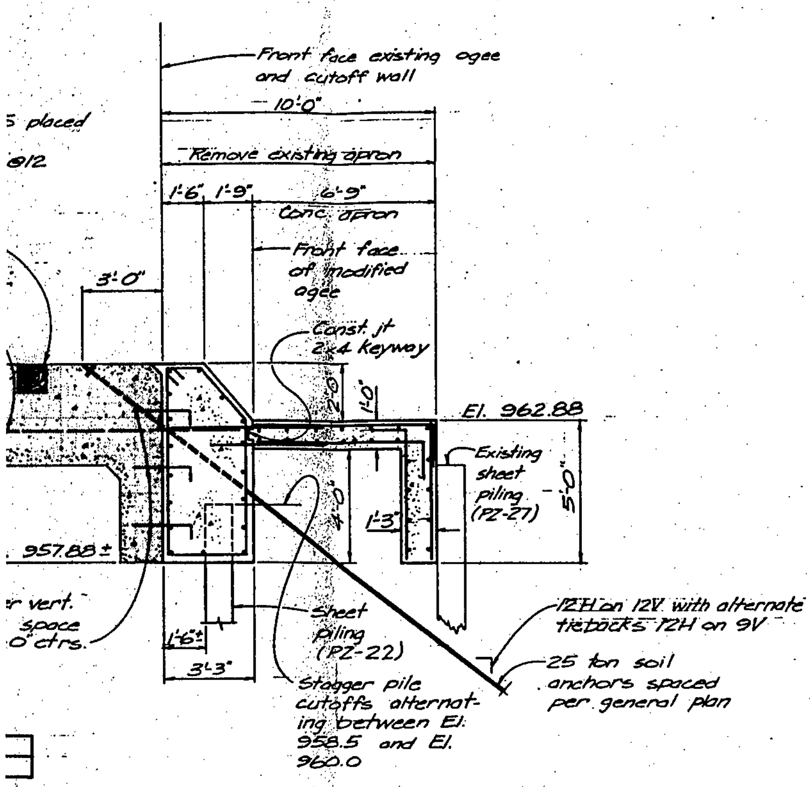
$\frac{3}{8}" = 1'-0"$

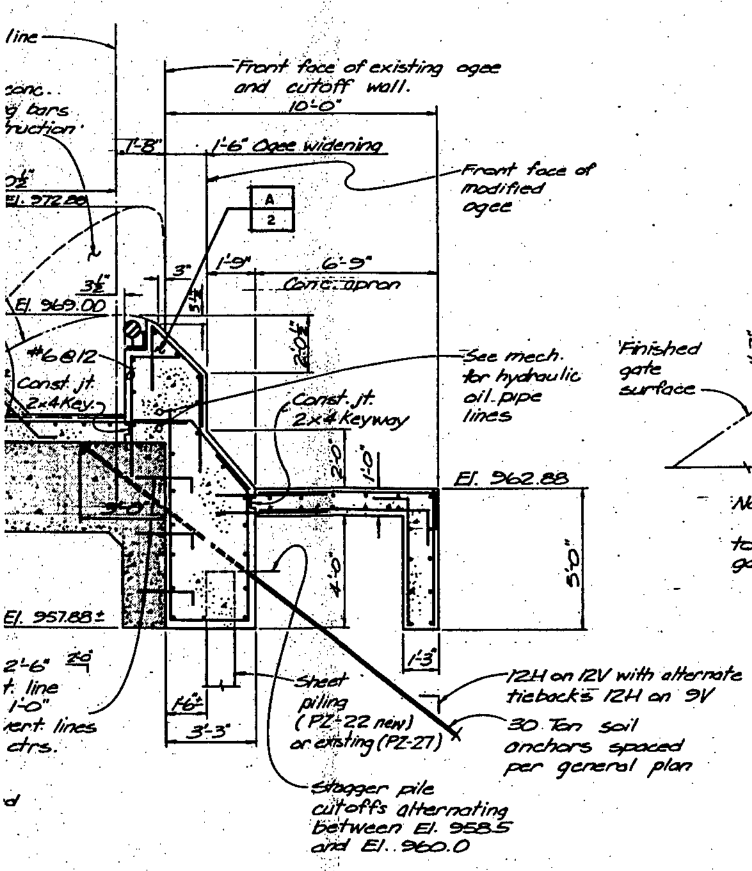
GENERAL NOTES :

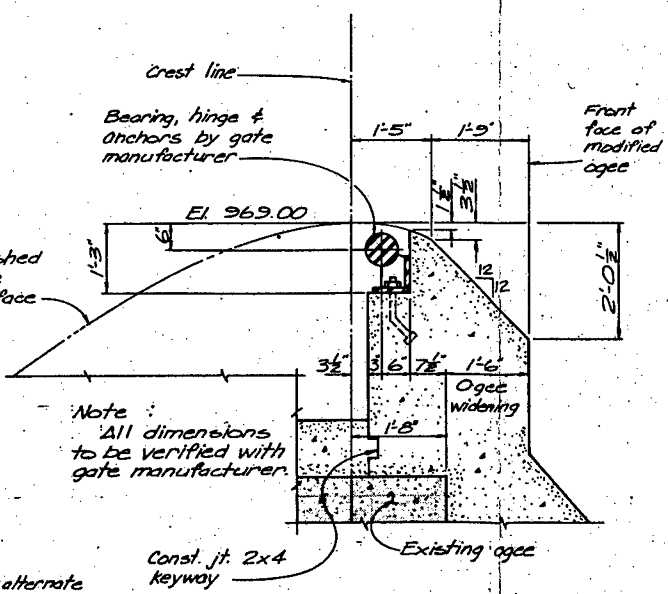
Transverse construc
of modified ogee c
made at same locat
though existing oge

Prior to placing fre
existing concrete su
be thoroughly clean
high pressure water
then be coated with
bonding agent applic
instructions. Typical
entire project.

Dowel bars into e
shall be placed by
All dowels shall, c
be set to a depth
full strength of th







DETAIL A / 2

$\frac{3}{4}" = 1'-0"$

LEGEND

New conc

Existing c

PREPARED BY
SHORT ELLIOTT HENDRICKSO
ST. PAUL, MINNESOTA & CHIPPEWA FA

T.C.B.
D.L.F./J.L.P.
J.L.P./T.C.B.
SUBMITTED BY:
DESIGN
APPROVE

SAFETY PAYS

2

GENERAL NOTES :

Transverse construction joints through new work of modified ogee and paved apron shall be made at same locations as transverse joints though existing ogee.

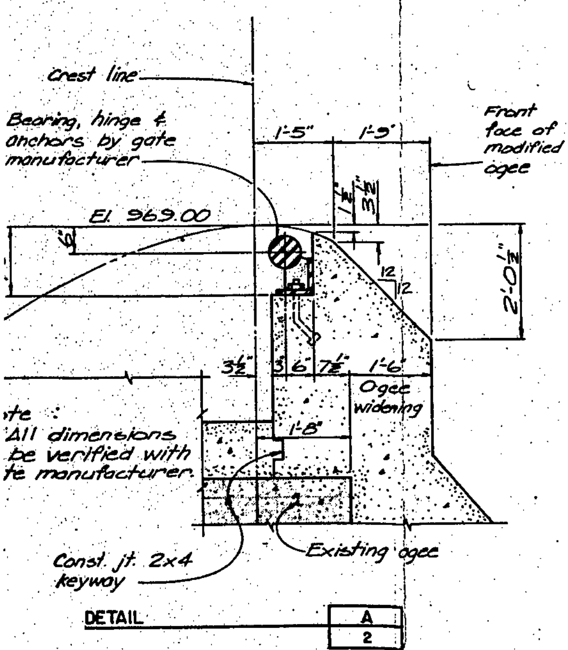
Prior to placing fresh concrete in contact with existing concrete surfaces, such surfaces shall be thoroughly cleaned by sand blasting or high pressure water jetting. The surfaces shall then be coated with an approved bonding agent applied per manufacturers instructions. Typical for entire project.

Dowel bars into existing concrete surfaces shall be placed by drilling and epoxy grouting. All dowels shall, unless otherwise noted, be set to a depth that will develop the full strength of the bar.

LEGEND

New concrete

Existing concrete



DETAIL A / 2

0 1 2 3

¾" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

PREPARED BY SHORT ELLIOTT HENDRICKSON, INC. ST. PAUL, MINNESOTA ● CHIPPEWA FALLS, WISC.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: T.C.B.
DRAWN BY: D.L.F./J.L.P.
CHECKED BY: J.L.P./T.C.B.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 — FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM
OGEE SECTIONS

APPROVED: CHIEF ENGR. DIVISION

DATE: JUNE 1985

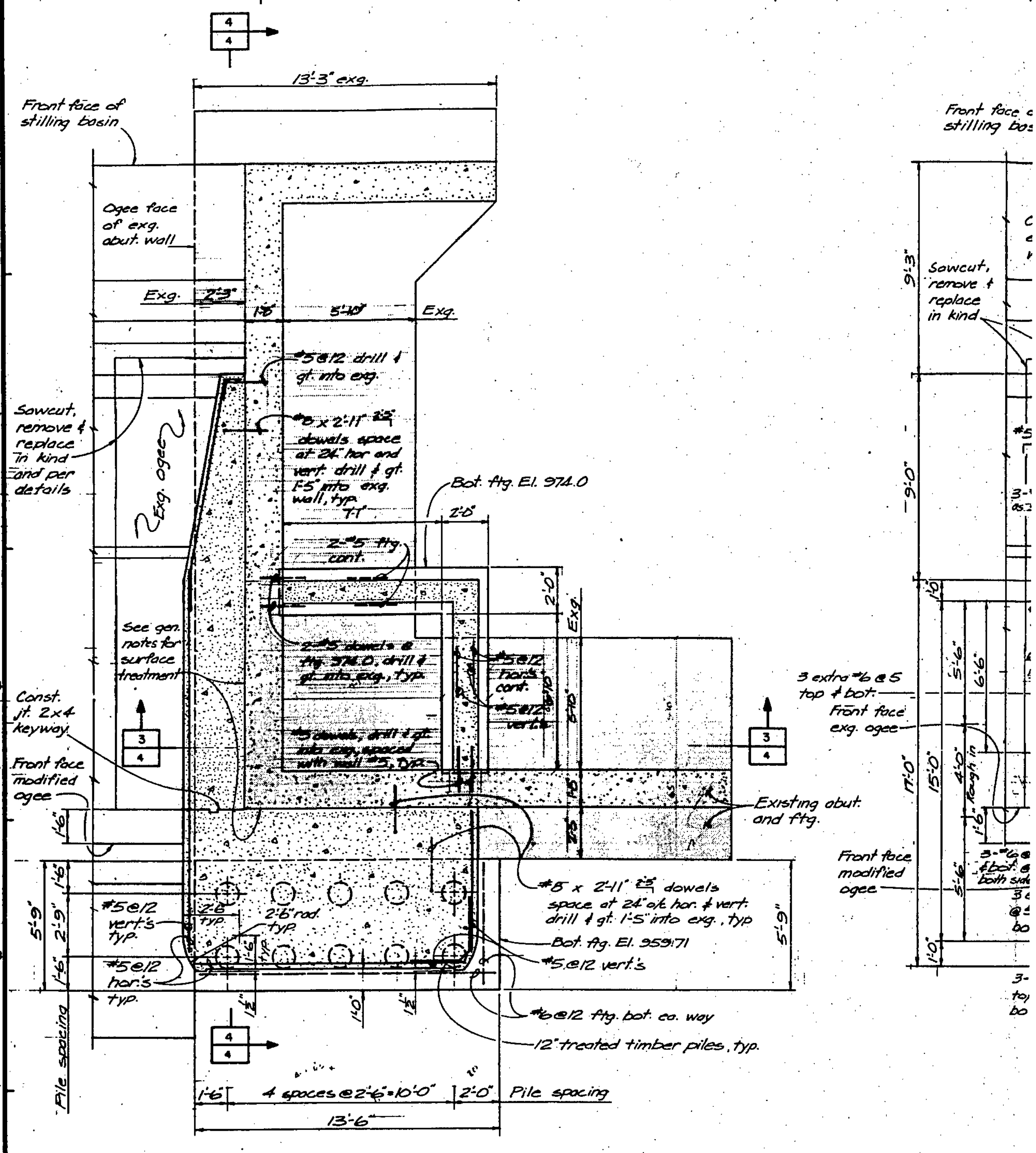
SCALE: AS SHOWN

DRAWING NUMBER M30-R-40/2

SHEET 25 OF 45

SAFETY PAYS

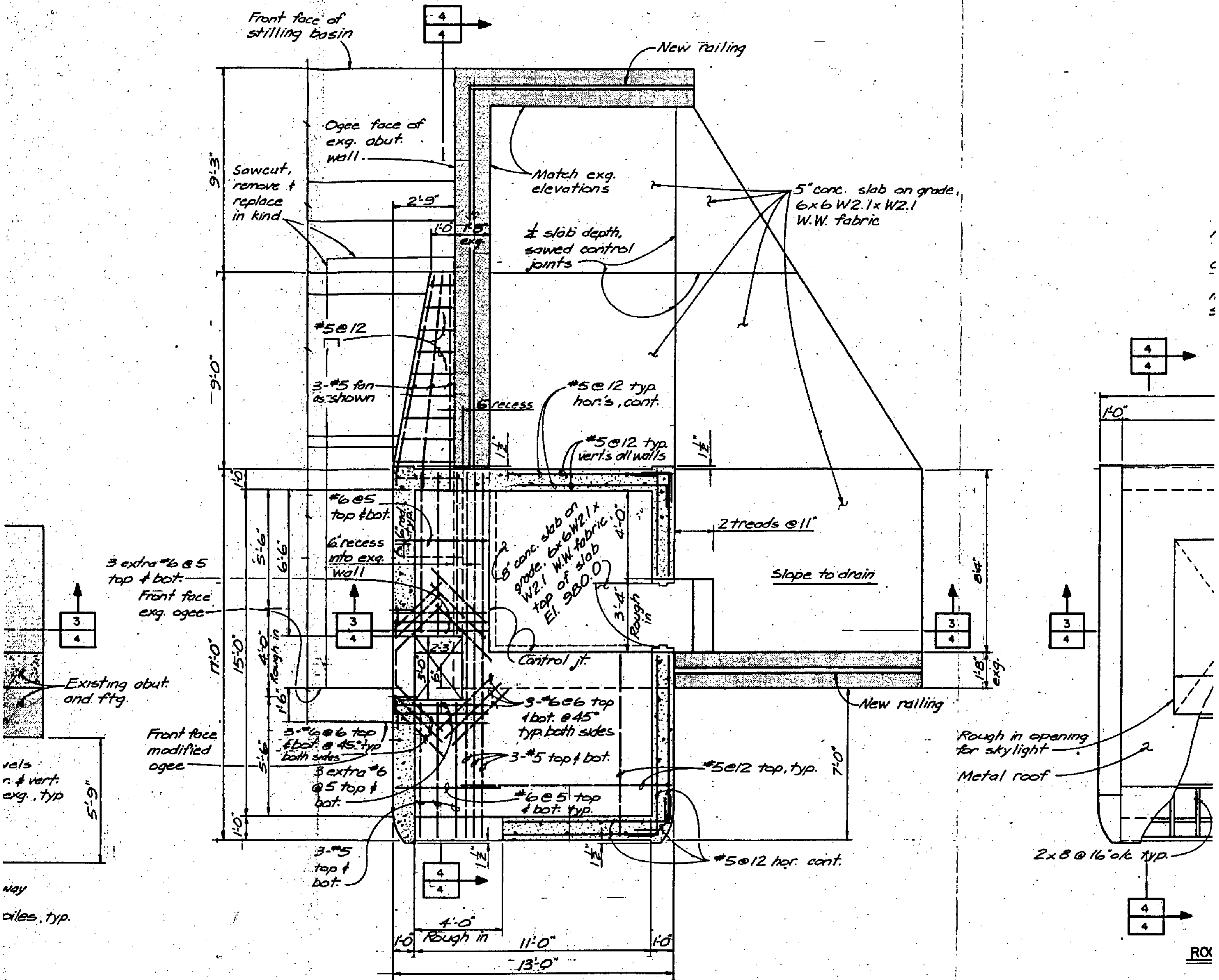
3



FOUNDATION PLAN

2 0 2 4 6

$\frac{3}{8}" = 1'-0"$



Note:
Gate lift equipment & floor mounted cylinder support not shown.

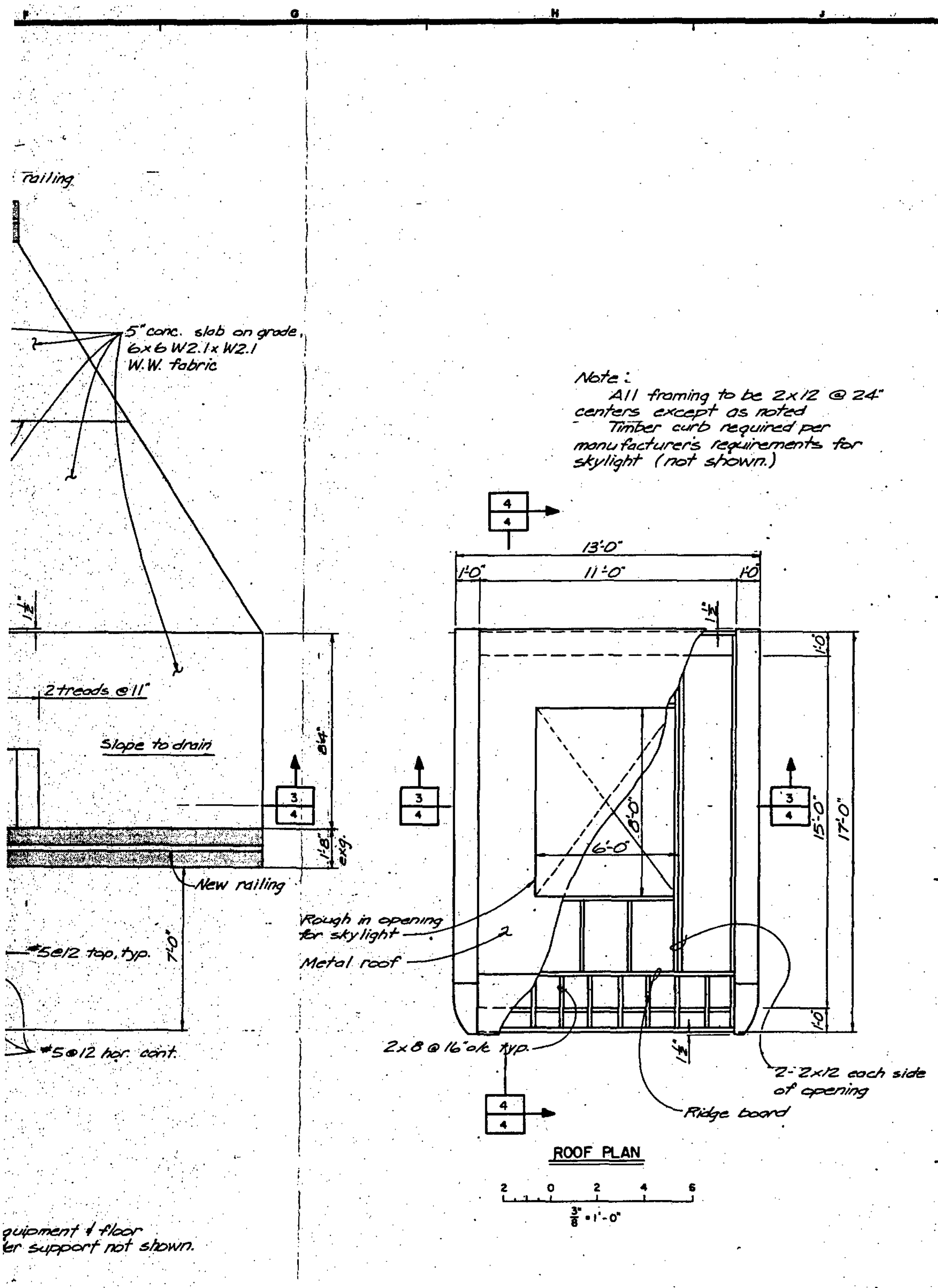
FIRST FLOOR PLAN

2 0 2 4 6
$\frac{3}{8}"$ = 1'-0"

SYMBOL
SHORT ELLIOT
ST. PAUL, MINNESOT
DESIGNED BY: T.C.B.
DRAWN BY: D.L.F./J.L.F
CHECKED BY: J.L.P./T.C.
SUBMITTED BY:

SAFETY PAYS

2



SYMBOL	DESCRIPTION	DATE	APPROVAL

PREPARED BY
SHORT ELLIOTT HENDRICKSON, INC.
ST. PAUL, MINNESOTA & CHIPPEWA FALLS, WISC.

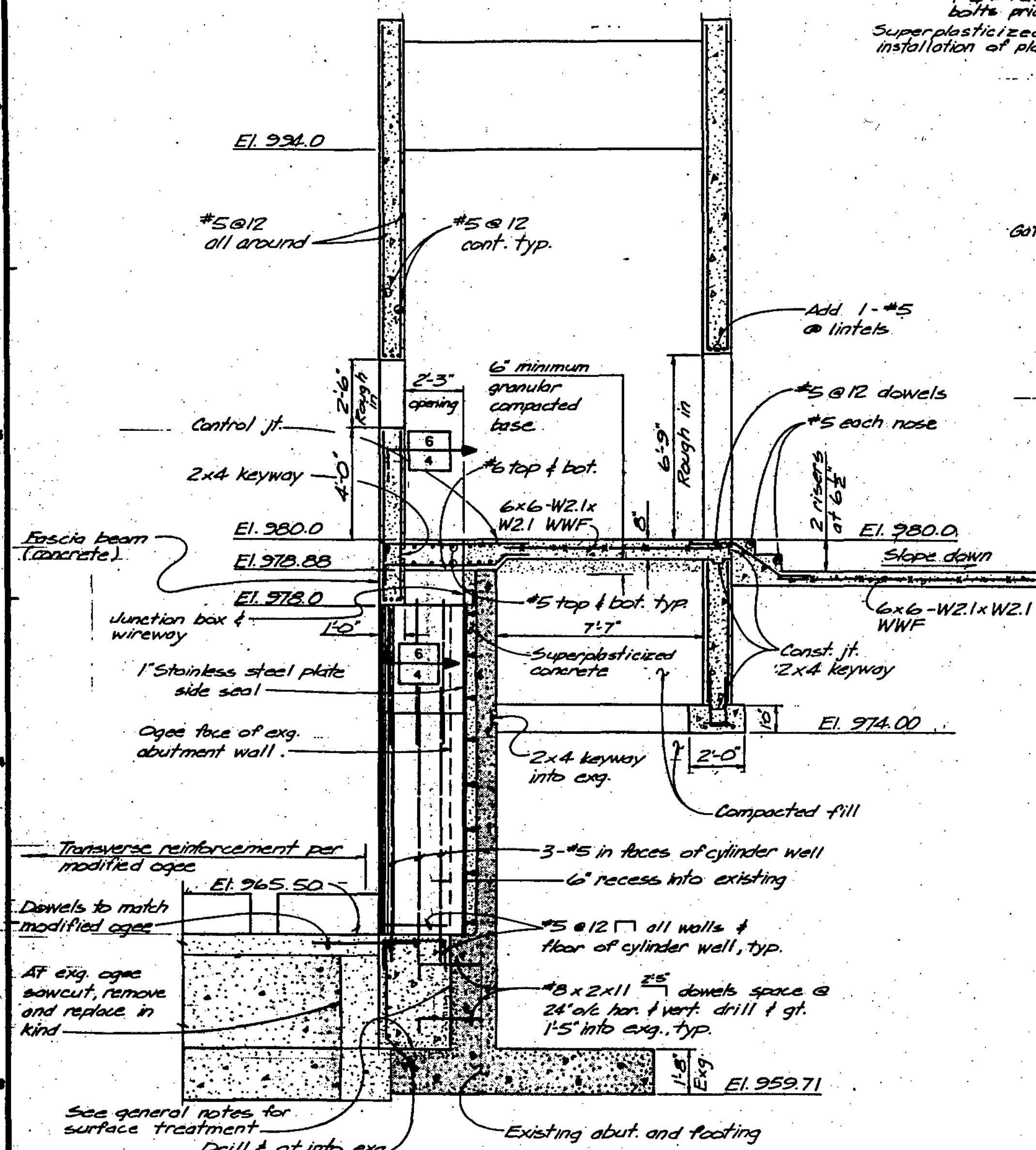
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: T.C.B.
DRAWN BY: D.L.F./J.L.P.
CHECKED BY: J.L.P./T.C.B.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM
RIGHT ABUTMENT PLAN

APPROVED BY:
DATE: JUNE 1985
SCALE: AS SHOWN
DRAWING NUMBER M30-R-40/3
SHEET 26 OF 45

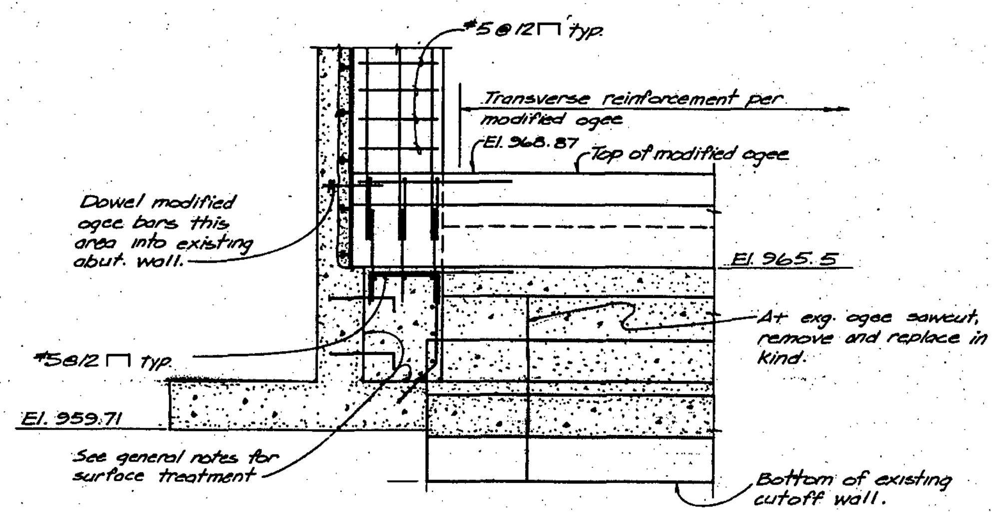
3



SECTION 3/3

2 0 2 4 6

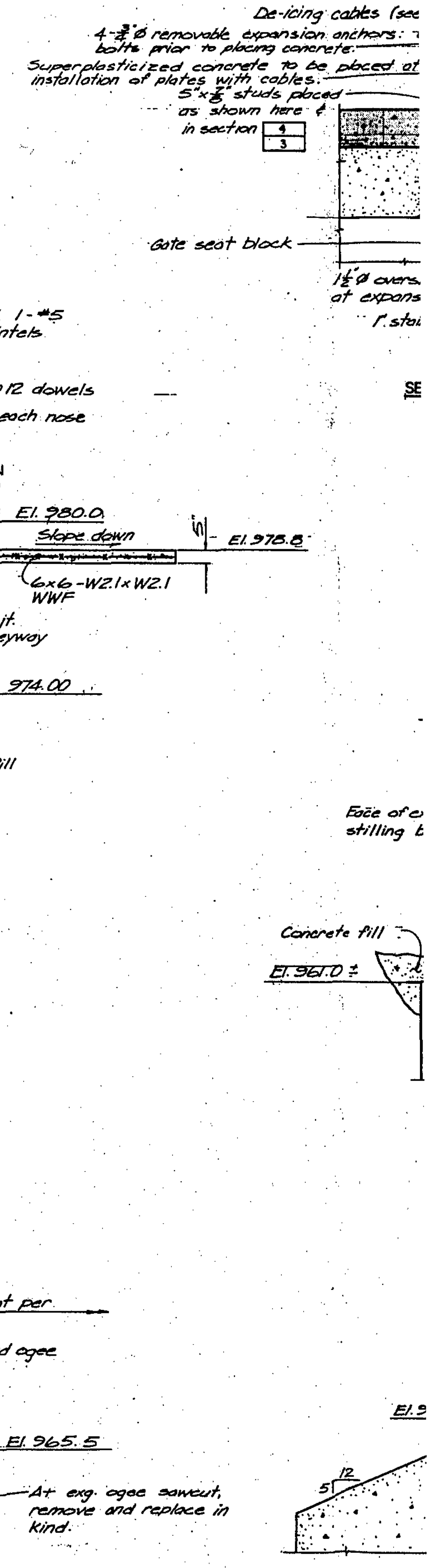
3/8" = 1'-0"



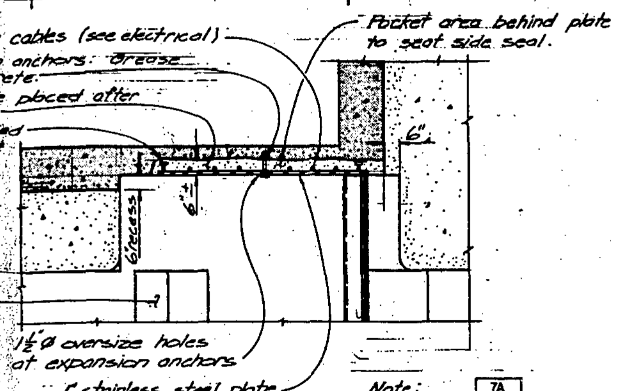
SECTION 5/4

2 0 2 4 6

3/8" = 1'-0"



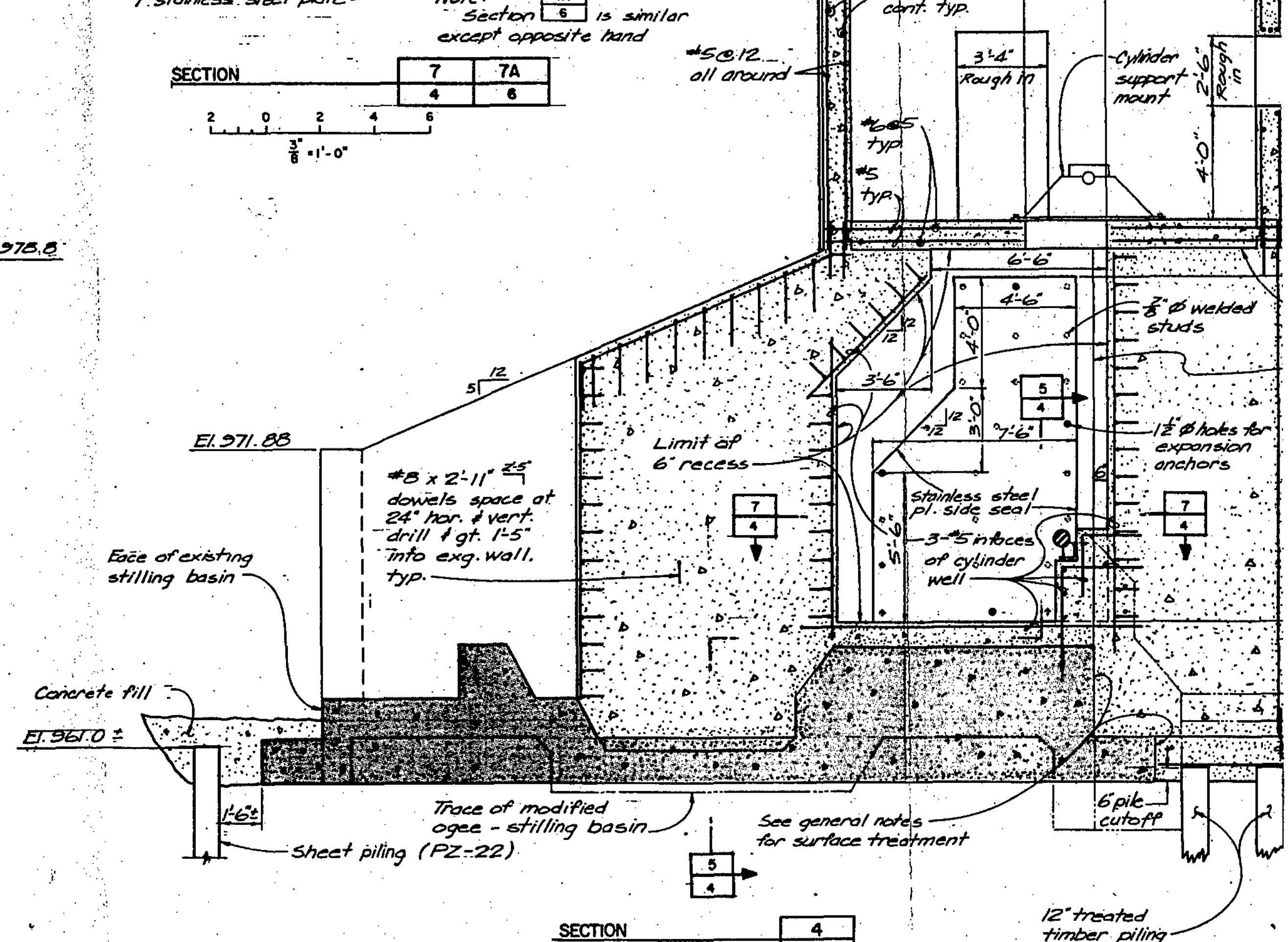
:980.0
Slope down
5"
El. 978.8
6x6-W2.1xW2.1
WWF



Note: Section 7A/6 is similar except opposite hand

SECTION 7/4 7A/6

3/8" = 1'-0"



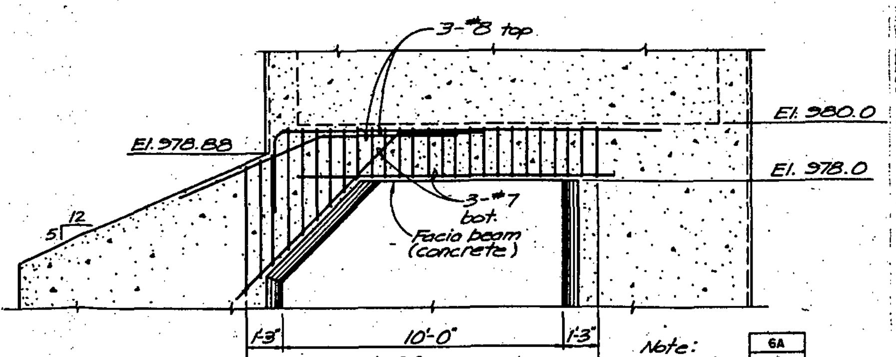
SECTION 4/3

3/8" = 1'-0"

965.5

At exg. ogee sawcut, remove and replace in kind.

Bottom of existing cutoff wall.



Note: Section 6A/6 is similar except opposite hand.

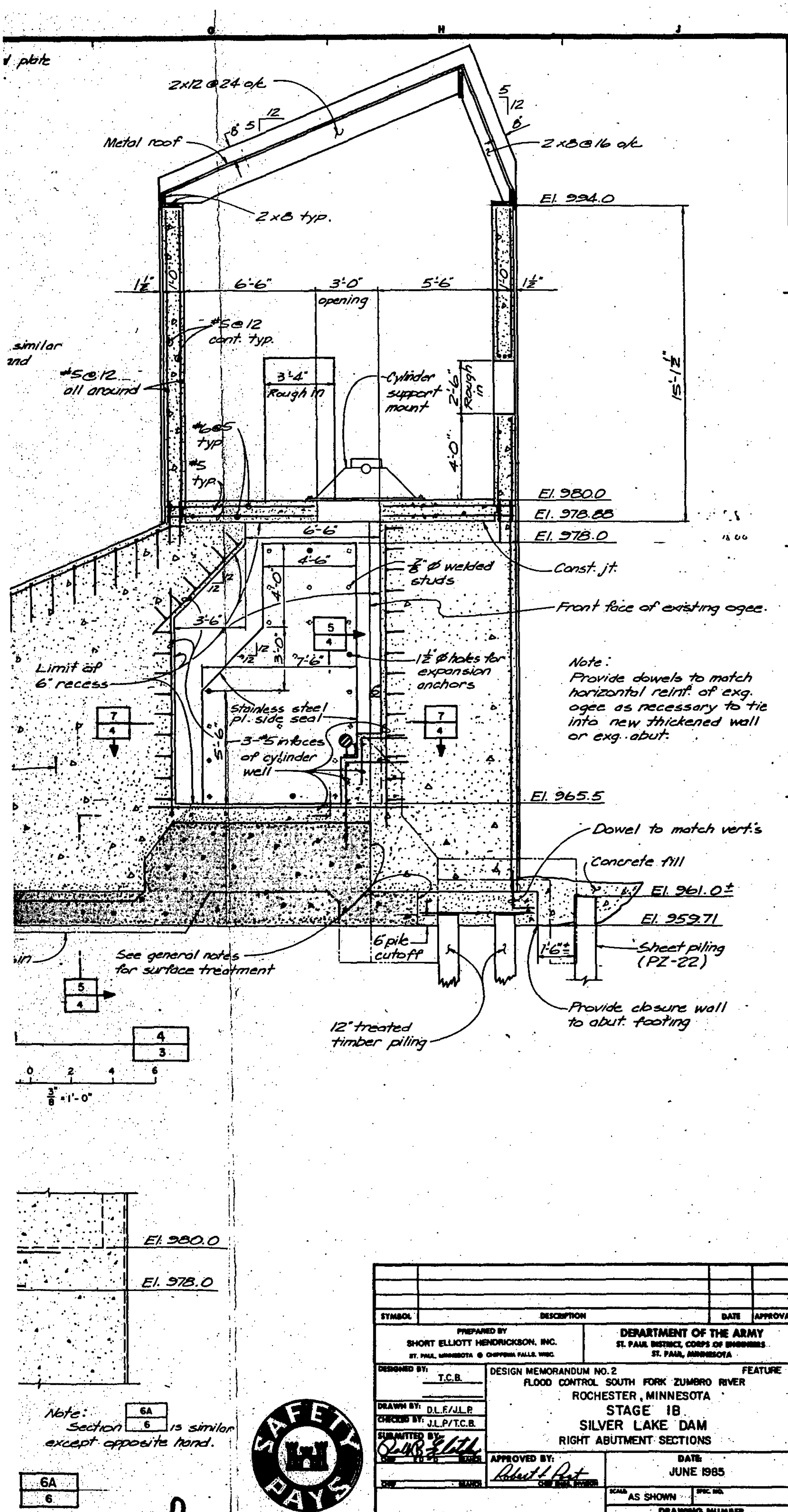
SECTION 6/4 6A/6

3/8" = 1'-0"

2

SAFETY PAYS

SYMBOL	
PREPARED BY SHORT ELLIOTT HENDRICKSON ST. PAUL, MINNESOTA & CHIPPEWA	
DESIGNED BY: T.C.B.	DESIG
DRAWN BY: D.L.F./J.L.P.	
CHECKED BY: J.L.P./T.C.B.	
SUBMITTED BY:	APPRO



SYMBOL	DESCRIPTION	DATE	APPROVAL

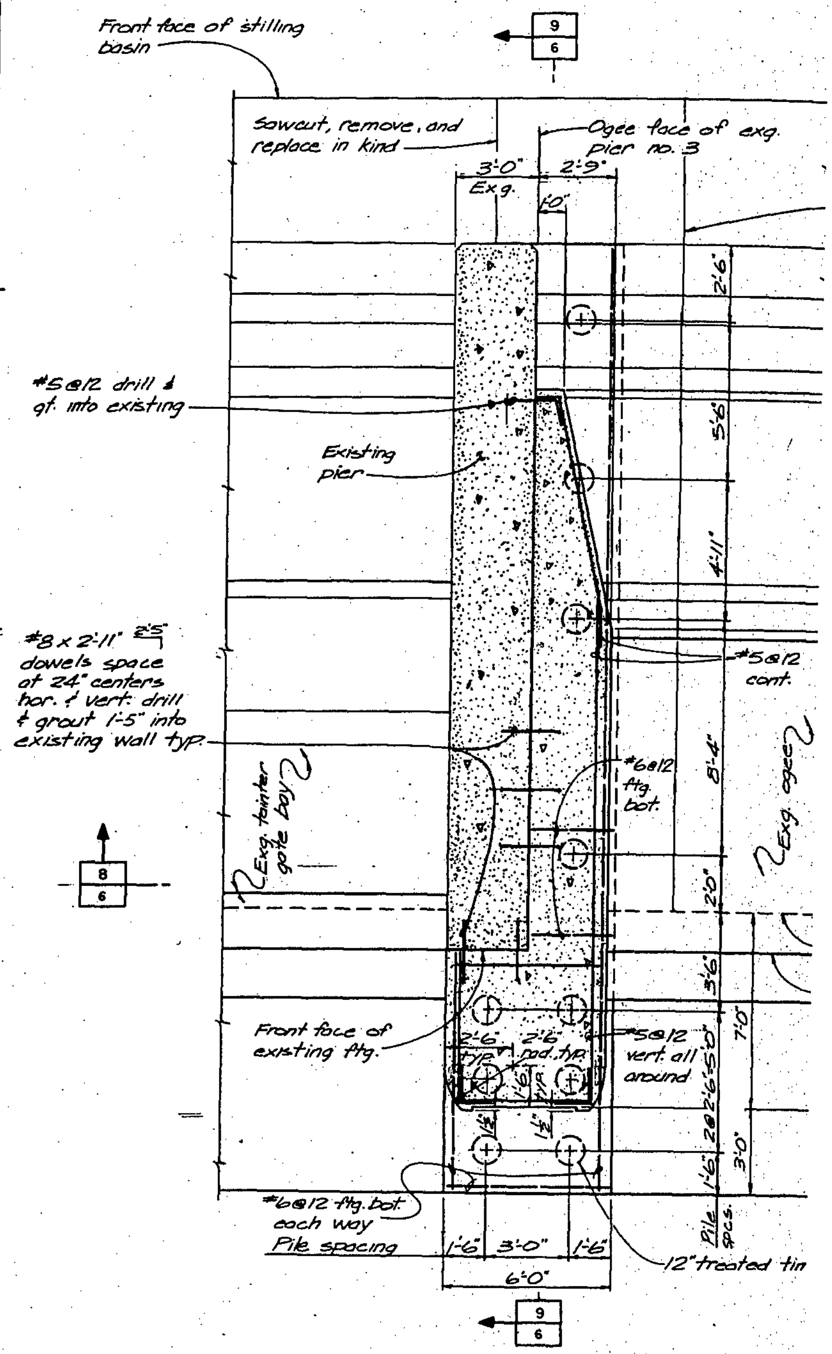
PREPARED BY
SHORT ELLIOTT HENDRICKSON, INC.
ST. PAUL, MINNESOTA ● CHIPPEWA FALLS, WISC.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: T.C.B.
DRAWN BY: D.L.F./J.L.P.
CHECKED BY: J.L.P./T.C.B.
SUBMITTED BY:

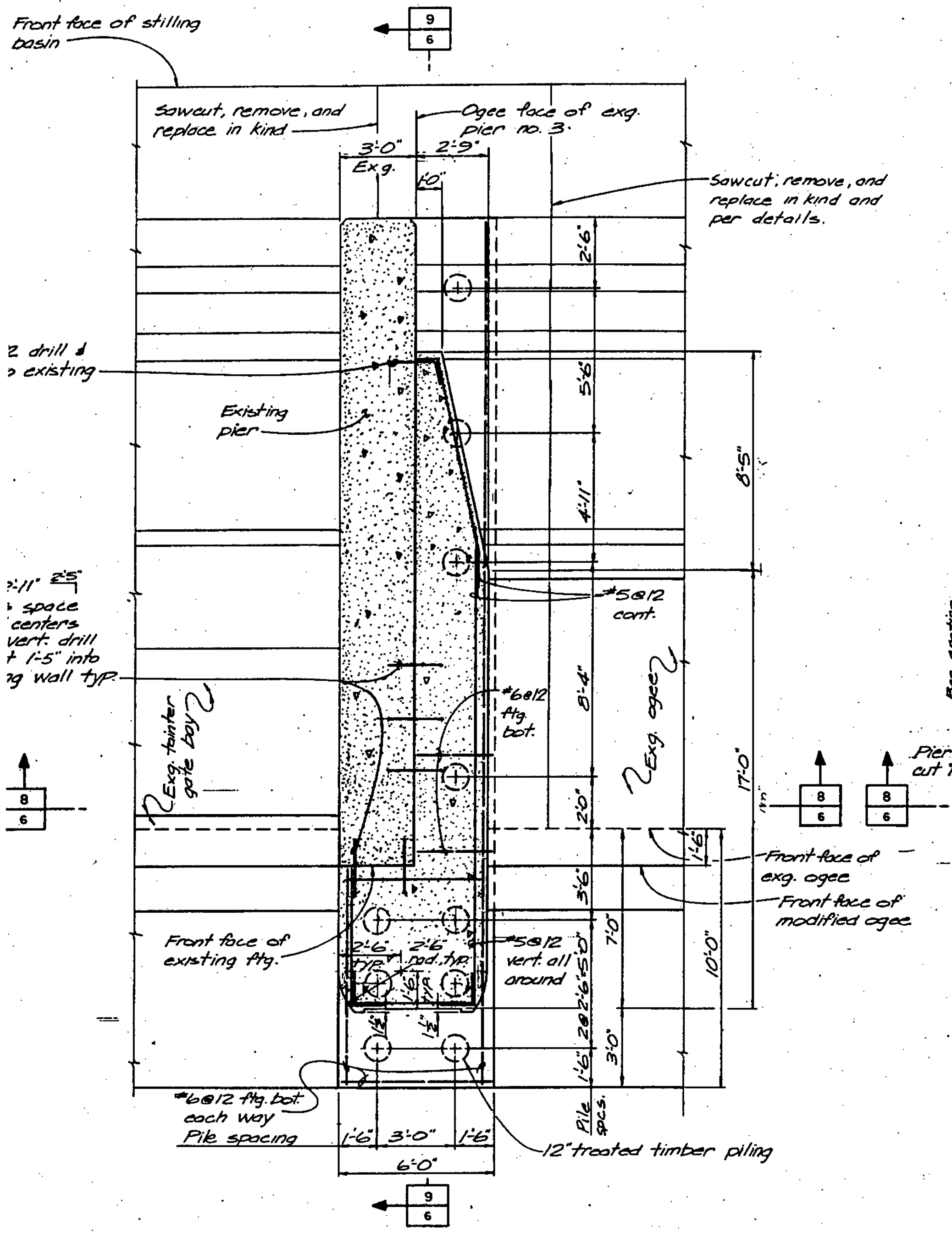
DESIGN MEMORANDUM NO. 2 — FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM
RIGHT ABUTMENT SECTIONS

APPROVED BY:
DATE: JUNE 1985
SCALE: AS SHOWN
DRAWING NUMBER M30-R-40/4
SHEET 27 OF 45



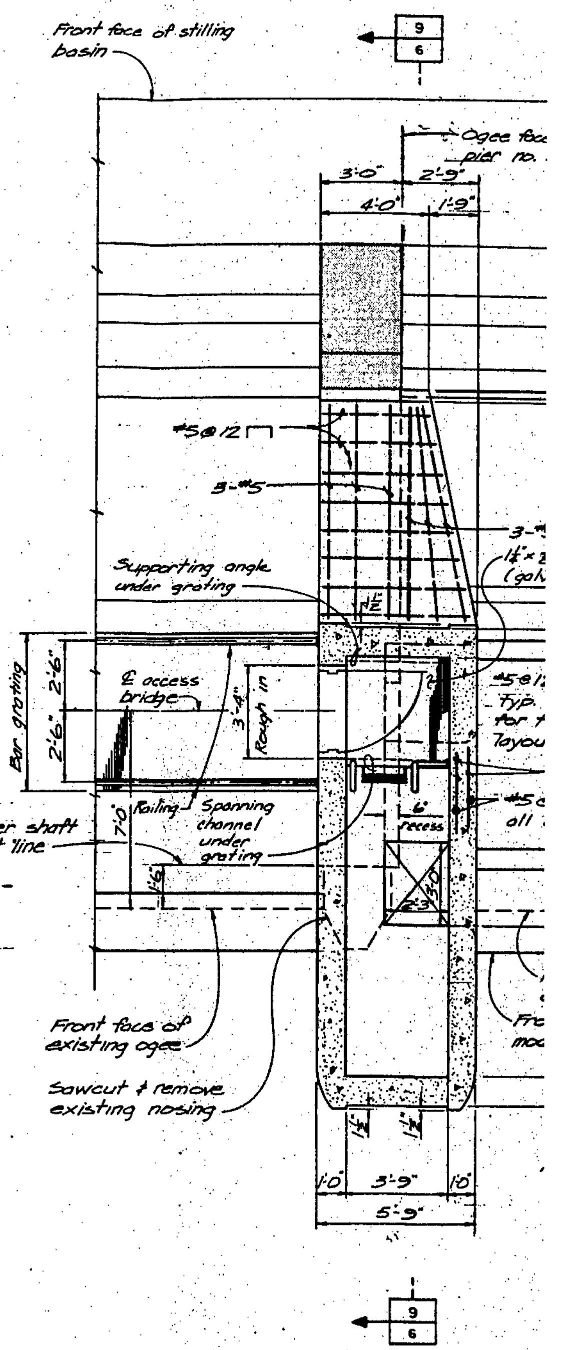
FOUNDATION PLAN

SCALE $\frac{3}{8}$" = 1'-0"



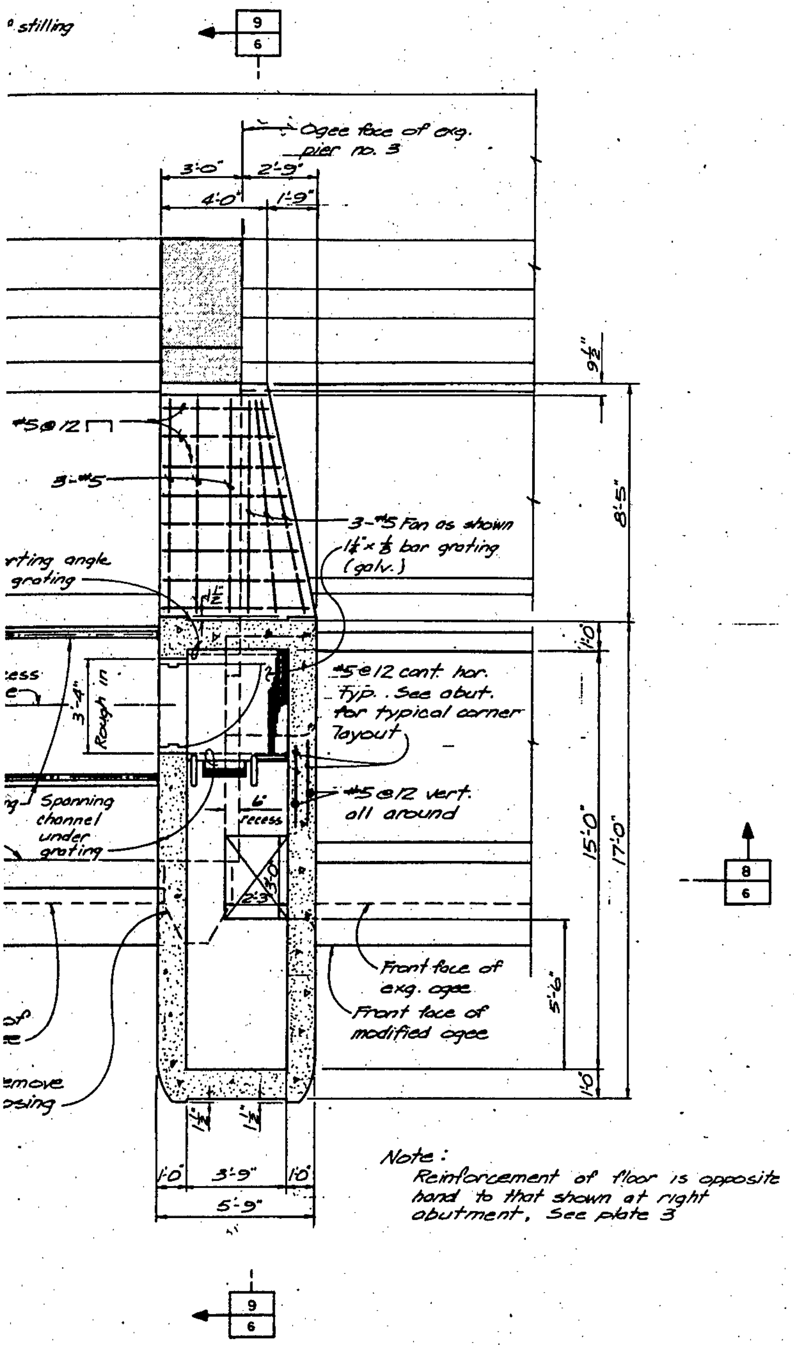
FOUNDATION PLAN

SCALE $\frac{3}{8}$" = 1'-0"



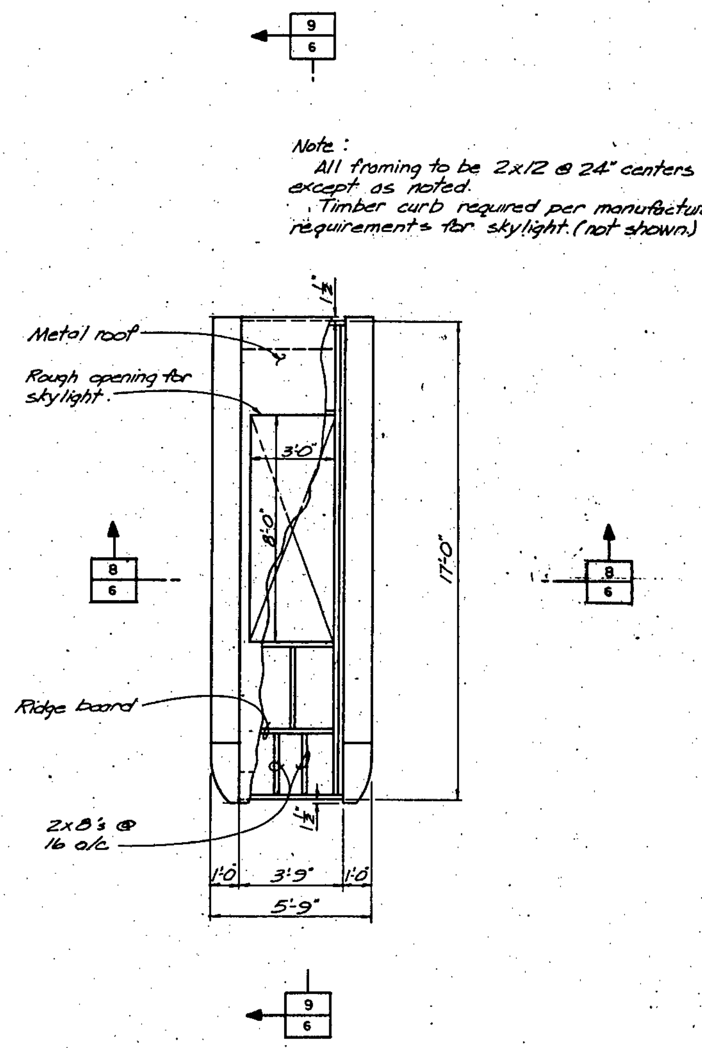
FIRST FLOOR PLAN

SCALE $\frac{3}{8}$" = 1'-0"



FIRST FLOOR PLAN

SCALE 3/8" = 1'-0"



ROOF PLAN

SCALE 3/8" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

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DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

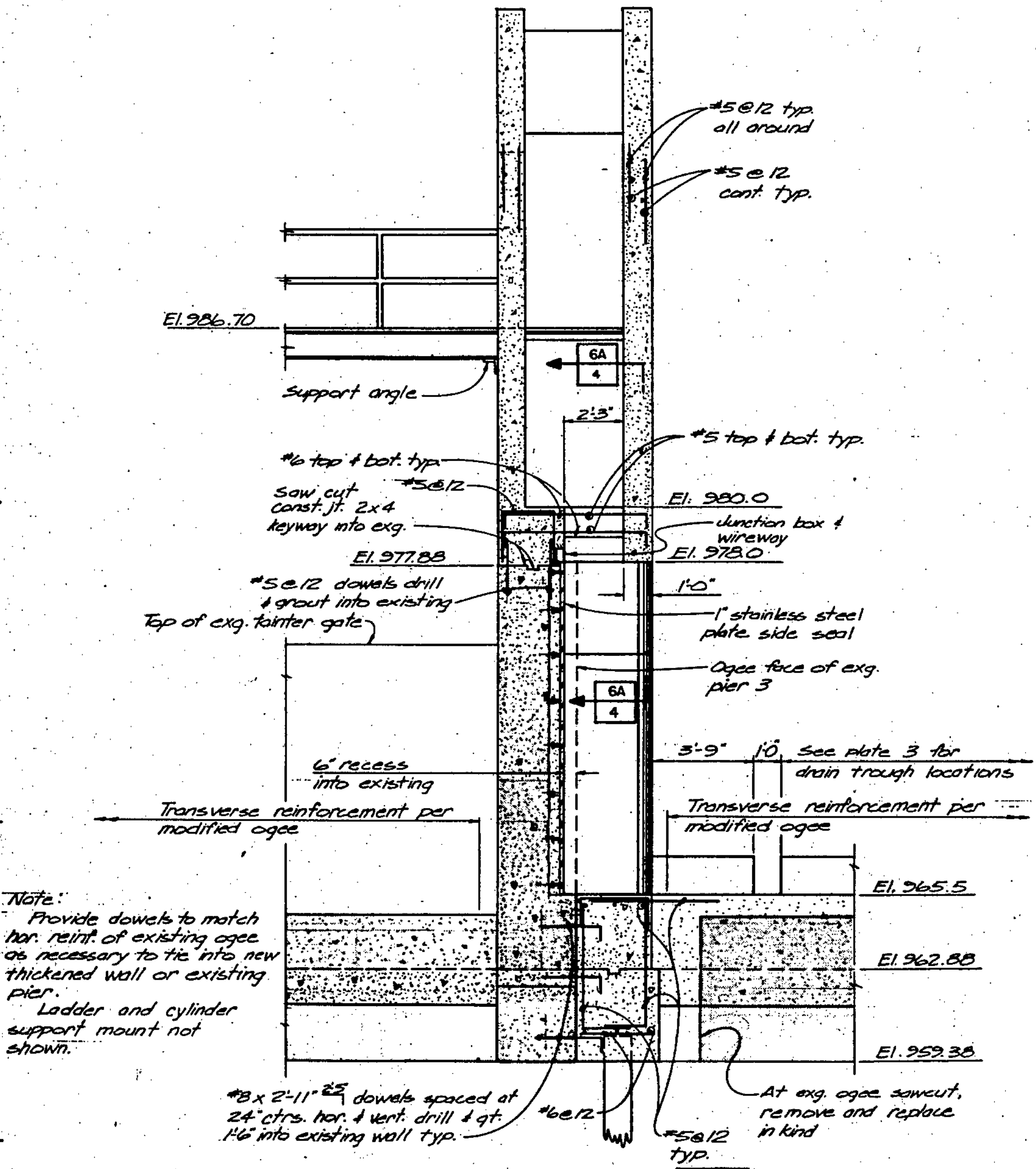
DESIGNED BY: T.C.B.
DRAWN BY: D.L.F./J.L.P.
CHECKED BY: J.L.P./T.C.B.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM
PIER 3 PLAN

APPROVED BY:
CHIEF ENGR. DIVISION

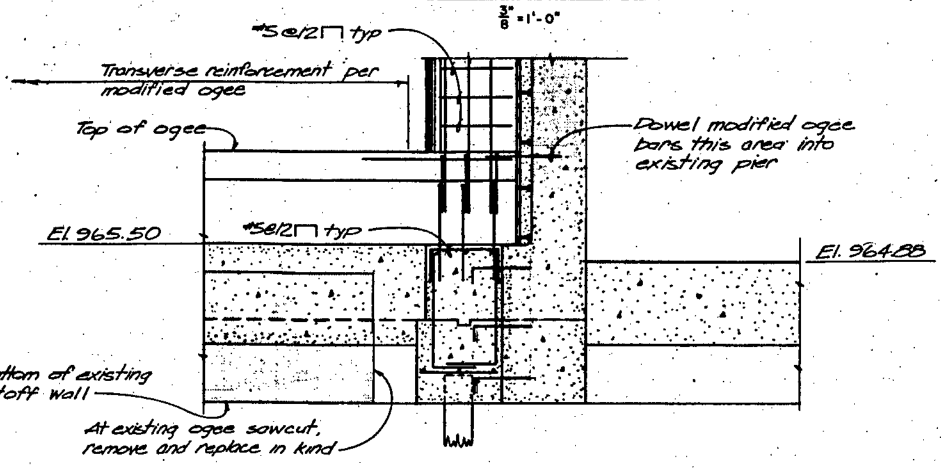
DATE: JUNE 1985
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-40/5
SHEET 28 OF 45

3



SECTION 8/5

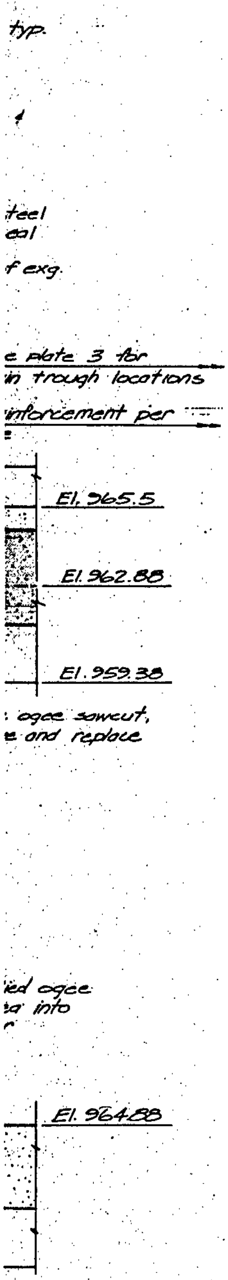
2 0 2 4 6
3/8" = 1'-0"

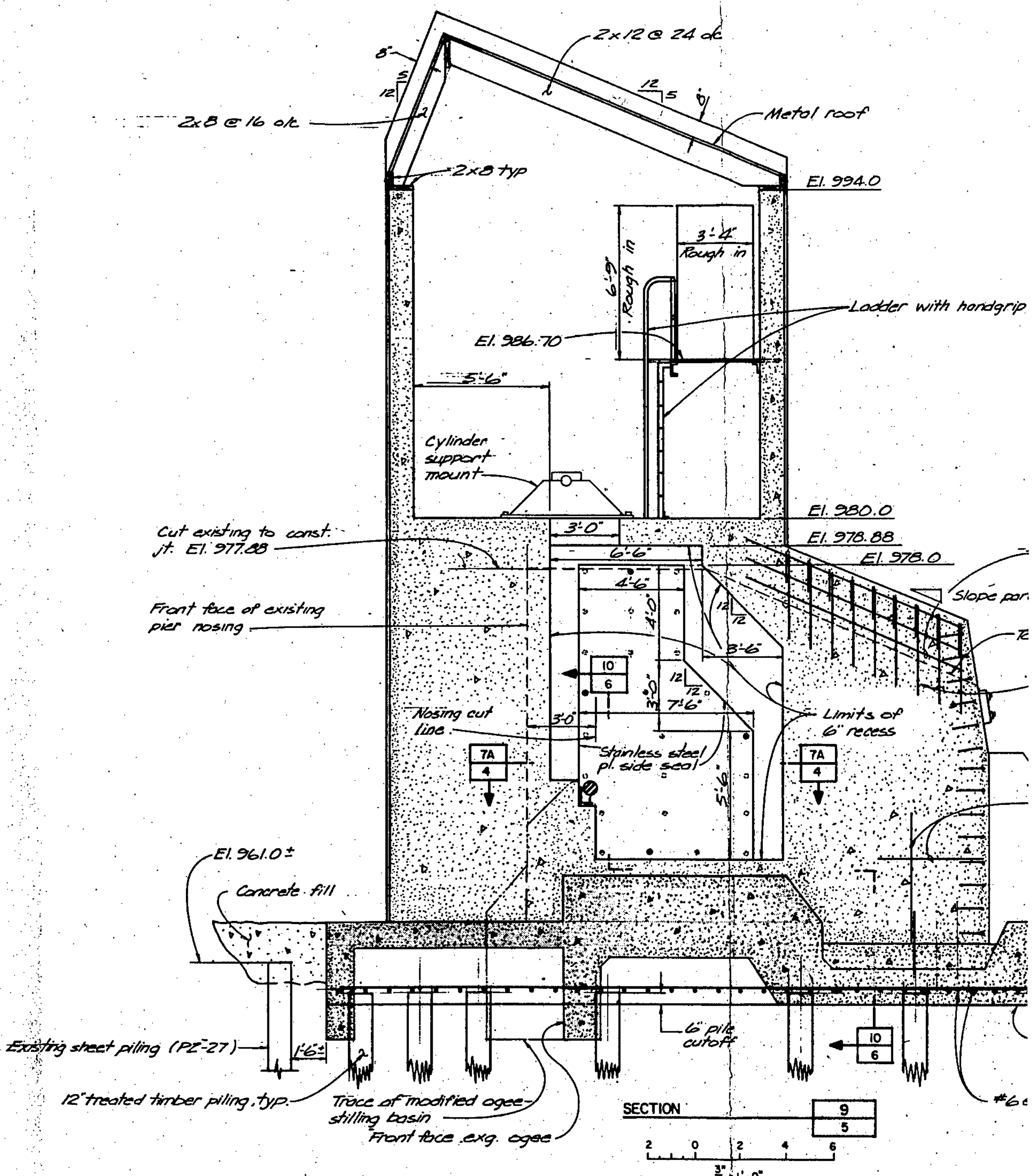


SECTION 10/6

2 0 2 4 6
3/8" = 1'-0"

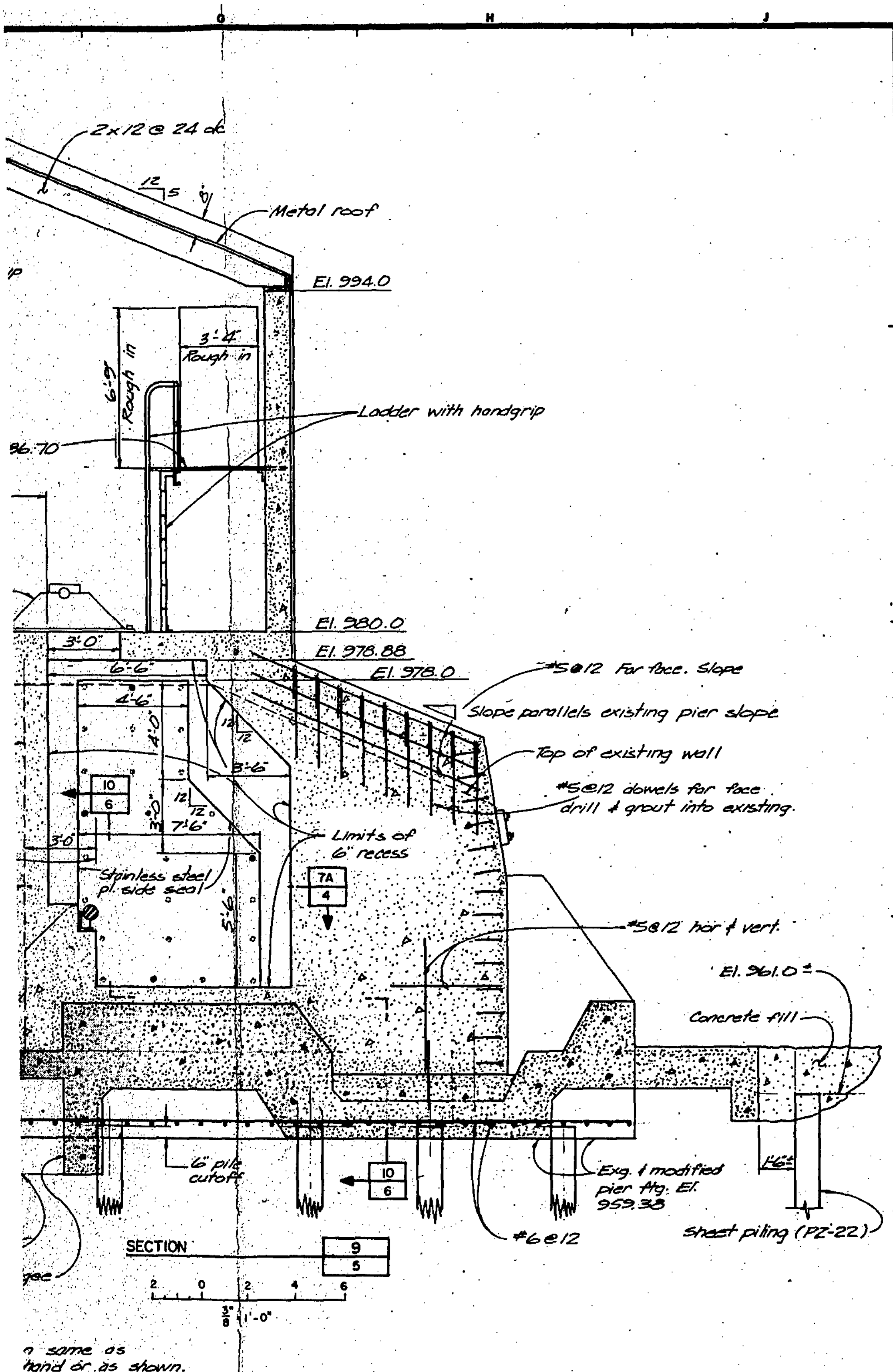
Cu. jt.
Fra pier
Existing sheet piling (.
12" treated tim.





Note:
Reinforcement of this section same as section 4/3 except opposite hand or as shown.

2



n same as
hand or as shown.

SYMBOL	DESCRIPTION	DATE	APPROVAL

PREPARED BY SHORT ELLIOTT HENDRICKSON, INC. ST. PAUL, MINNESOTA • CHIPPEWA FALLS, WISC.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

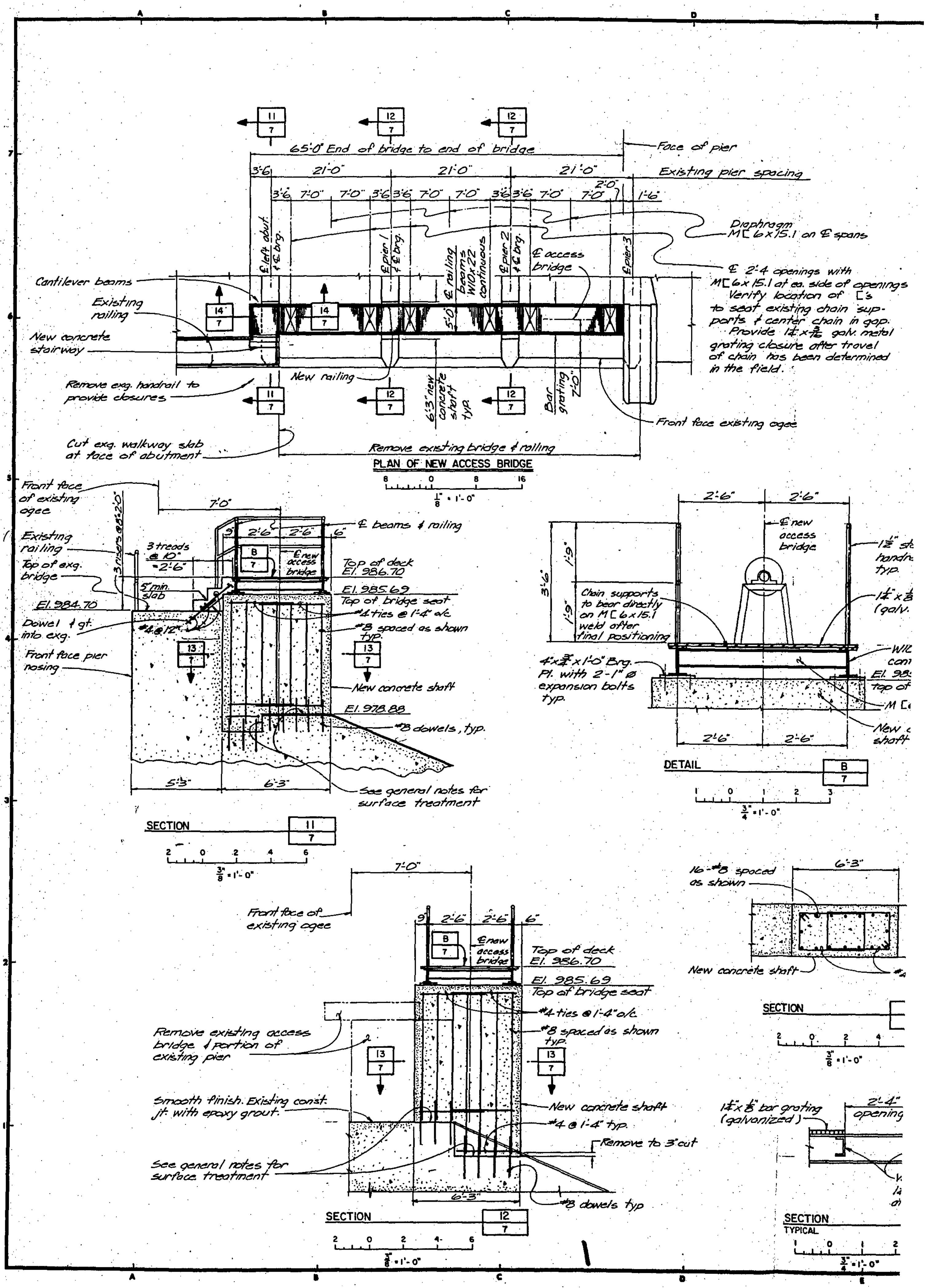
DESIGNED BY: T.C.B.
DRAWN BY: D.L.F./J.L.P.
CHECKED BY: J.L.P./T.C.B.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
SILVER LAKE DAM
PIER 3 SECTIONS

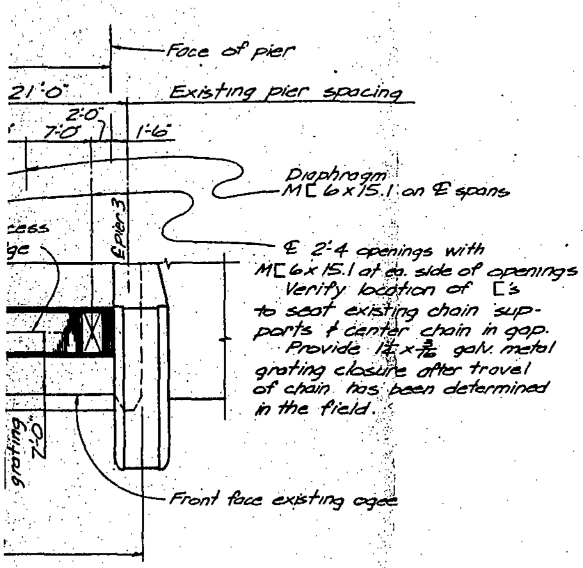
APPROVED BY:
DATE: JUNE 1985
SCALE: AS SHOWN
DRAWING NUMBER M30-R-40/6
SHEET 29 OF 45

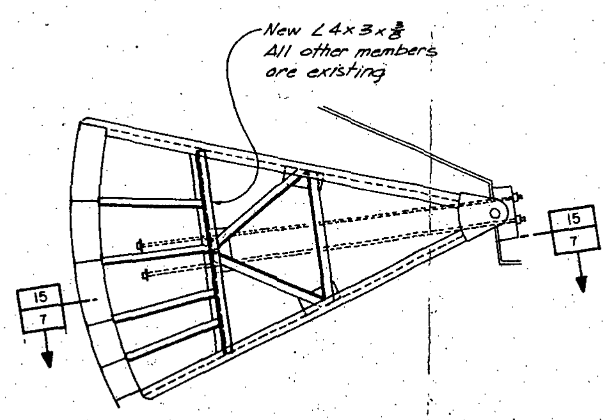
SAFETY PAYS

3



A
B
C
D
E
7
6
5
4
3
2
1
11 / 7
12 / 7
12 / 7
65'-0" End of bridge to end of bridge
Face of pier
3'-6"
21'-0"
21'-0"
21'-0"
Existing pier spacing
3'-6" 7'-0" 7'-0" 3'-6" 3'-6" 7'-0" 7'-0" 3'-6" 3'-6" 7'-0" 7'-0"
2'-0"
1'-6"
Diaphragm
M[6x15.1 on ℄ spans
℄ left abut. ⅋ ℄ brg.
℄ pier 1 ⅋ ℄ brg.
℄ railing
beams W10x22 continuous
℄ pier 2 ⅋ ℄ brg.
℄ access bridge
℄ pier 3
℄ 2'-4" openings with M[6x15.1 at ea. side of openings. Verify location of ['s to seat existing chain supports ⅋ center chain in gap. Provide 1¼"x3/16" galv. metal grating closure after travel of chain has been determined in the field.
Cantilever beams
Existing railing
New concrete stairway
14 / 7
14 / 7
5'-0"
Remove exg. handrail to provide closures
New railing
6'-3" new concrete shaft typ.
Bar grating 7'-0"
Front face existing ogee
Cut exg. walkway slab at face of abutment
Remove existing bridge ⅋ railing
PLAN OF NEW ACCESS BRIDGE
8 0 8 16
1/8" = 1'-0"
Front face of existing ogee
7'-0"
3 risers @ 8½"=2'-0"
Existing railing
3 treads @ 10" = 2'-6"
Top of exg. bridge
9" 2'-6" 2'-6" 6"
℄ beams ⅋ railing
B / 7
℄ new access bridge
Top of deck El. 986.70
El. 985.69
Top of bridge seat
5" min. slab
El. 984.70
#4 ties @ 1'-4" o/c
Dowel ⅋ gt. into exg.
#4 @ 12"
#8 spaced as shown typ.
Front face pier nosing
13 / 7
13 / 7
New concrete shaft
El. 978.88
#8 dowels, typ.
5'-3"
6'-3"
See general notes for surface treatment
SECTION 11 / 7
2 0 2 4 6
3/8" = 1'-0"
2'-6"
2'-6"
℄ new access bridge
3'-6"
1'-9"
1'-9"
Chain supports to bear directly on M[6x15.1 weld after final positioning
1½" st. handr. typ.
1¼" x 3/16" (galv.
W1(
con
El. 98
Top of
M [
New c shaft
4"x¾"x1'-0" Brg. Pl. with 2-1" ø expansion bolts typ.
2'-6"
2'-6"
DETAIL B / 7
1 0 1 2 3
3/4" = 1'-0"
7'-0"
Front face of existing ogee
9" 2'-6" 2'-6" 6"
B / 7
℄ new access bridge
Top of deck El. 986.70
El. 985.69
Top of bridge seat
#4 ties @ 1'-4" o/c
#8 spaced as shown typ.
Remove existing access bridge ⅋ portion of existing pier
13 / 7
13 / 7
Smooth finish. Existing const. jt. with epoxy grout.
New concrete shaft
#4 @ 1'-4" typ.
Remove to 3" cut
See general notes for surface treatment
6'-3"
#8 dowels typ
SECTION 12 / 7
2 0 2 4 6
3/8" = 1'-0"
16-#8 spaced as shown
6'-3"
New concrete shaft
SECTION
2 0 2 4
3/8" = 1'-0"
1¼"x3/16" bar grating (galvanized)
2'-4" opening
SECTION TYPICAL
1 0 1 2
3/4" = 1'-0"

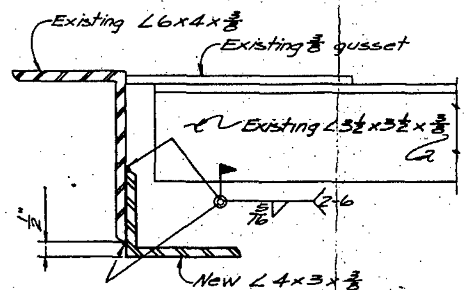




REINFORCEMENT OF TAINTER GATE

NTS

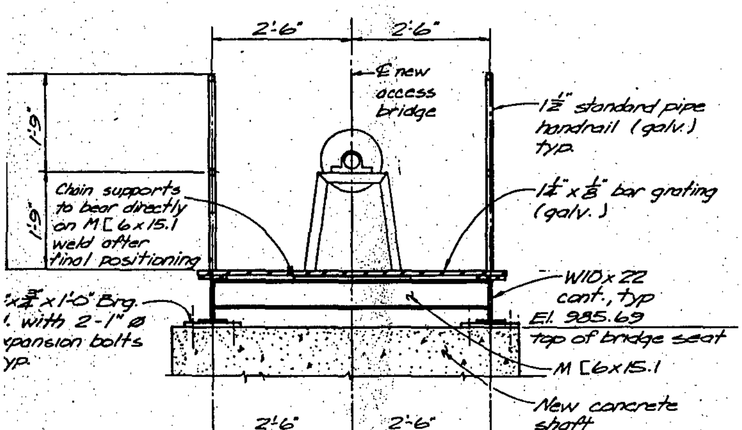
Existing



SECTION 15 / 7

2" 0 2" 4" 6"

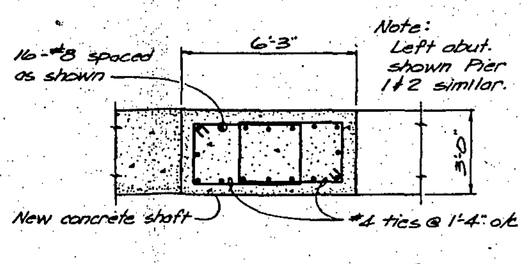
3/8" = 1"



DETAIL B / 7

1 0 1 2 3

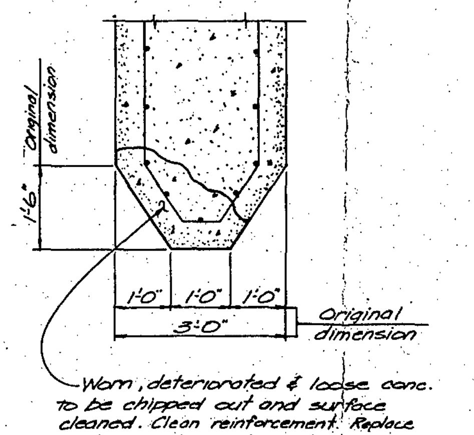
3/4" = 1'-0"



SECTION 13 / 7

2 0 2 4 6

3/8" = 1'-0"

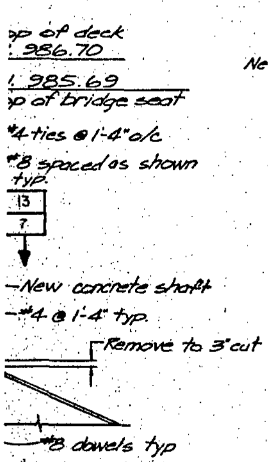


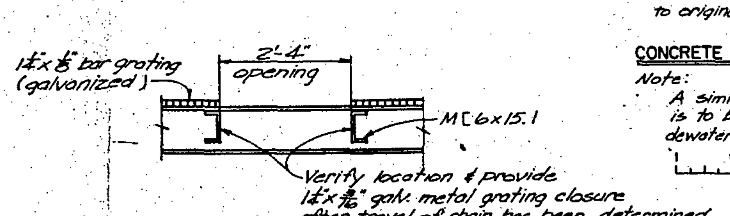
CONCRETE REPAIR AT PIER 1 & 2

Note:
A similar method of repair is to be used where construction dewatering exposes a need.

1 0 1 2 3

3/4" = 1'-0"





SECTION 14 / 7

TYPICAL

1 0 1 2 3

3/4" = 1'-0"

2

SYMBOL

PREPAR

SHORT ELLIOTT HE

ST. PAUL, MINNESOTA

DESIGNED BY: T.C.B.

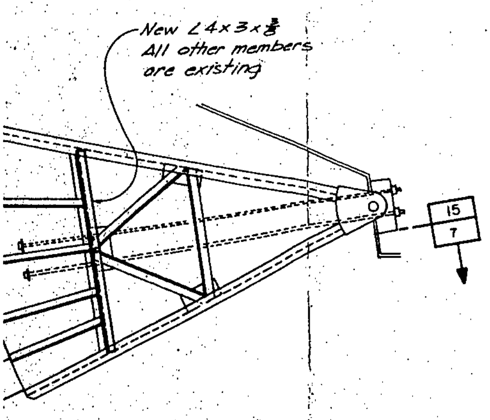
DRAWN BY: DLF/JLP

CHECKED BY: JLP/TCB

SUBMITTED BY:

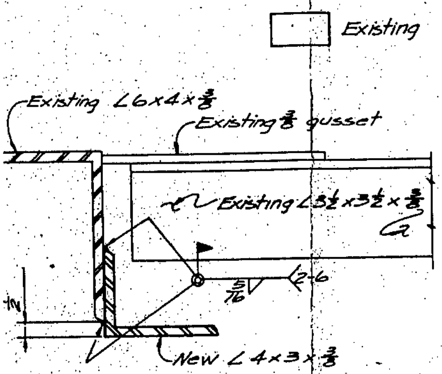
CHIEF D-D BRANCH

CHIEF BRANCH



INFORCEMENT OF TAINTER GATE

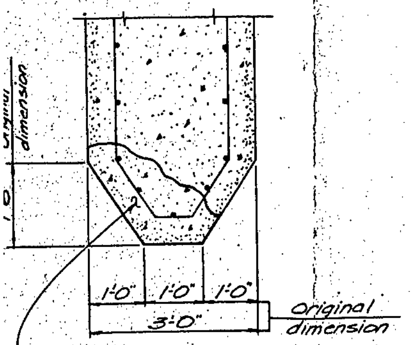
NTS



SECTION 15/7

2" 0 2" 4" 6"

3/8" = 1"



Worn, deteriorated & loose conc. to be chipped out and surface cleaned. Clean reinforcement. Replace reinforcement if deteriorated more than 20% with like size. Restore area to original dimensions with SHOTCRETE.

CONCRETE REPAIR AT PIER 1 & 2

Note:
A similar method of repair is to be used where construction dewatering exposes a need.

0 1 2 3

3/4" = 1'-0"

etermined.

3

SYMBOL	DESCRIPTION	DATE	APPROVAL

PREPARED BY SHORT ELLIOTT HENDRICKSON, INC. ST. PAUL, MINNESOTA ● CHIPPEWA FALLS, WISC.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: T.C.B.
DRAWN BY: DLF/JLP
CHECKED BY: JLP/TCB
SUBMITTED BY: [signature] CHIEF ED-D BRANCH

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM
ACCESS BRIDGE AND DETAILS

APPROVED: [signature] CHIEF ENGR. DIVISION

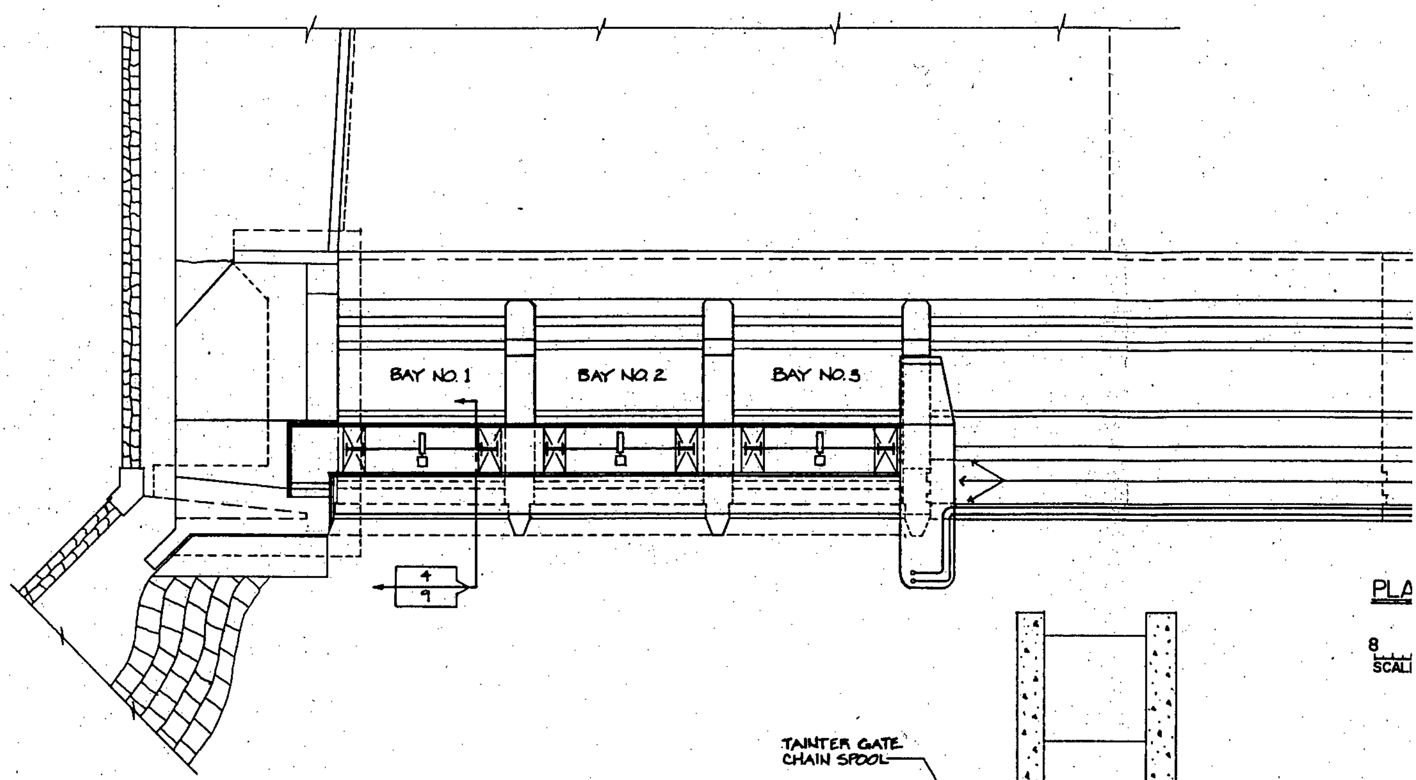
DATE: JUNE 1985

SCALE: AS SHOWN

DRAWING NUMBER M30-R-40/7

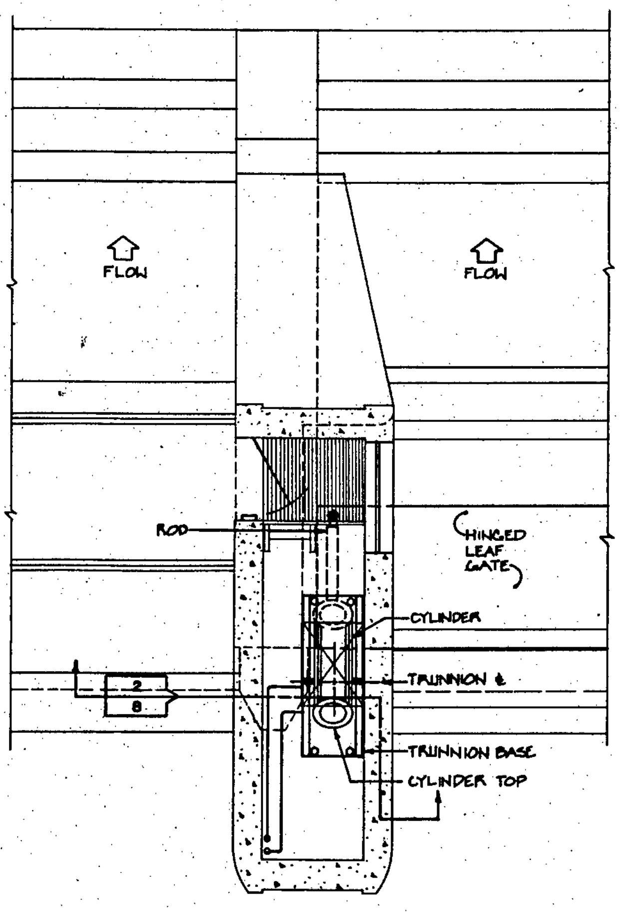
SHEET 30 OF 45

SAFETY PAYS



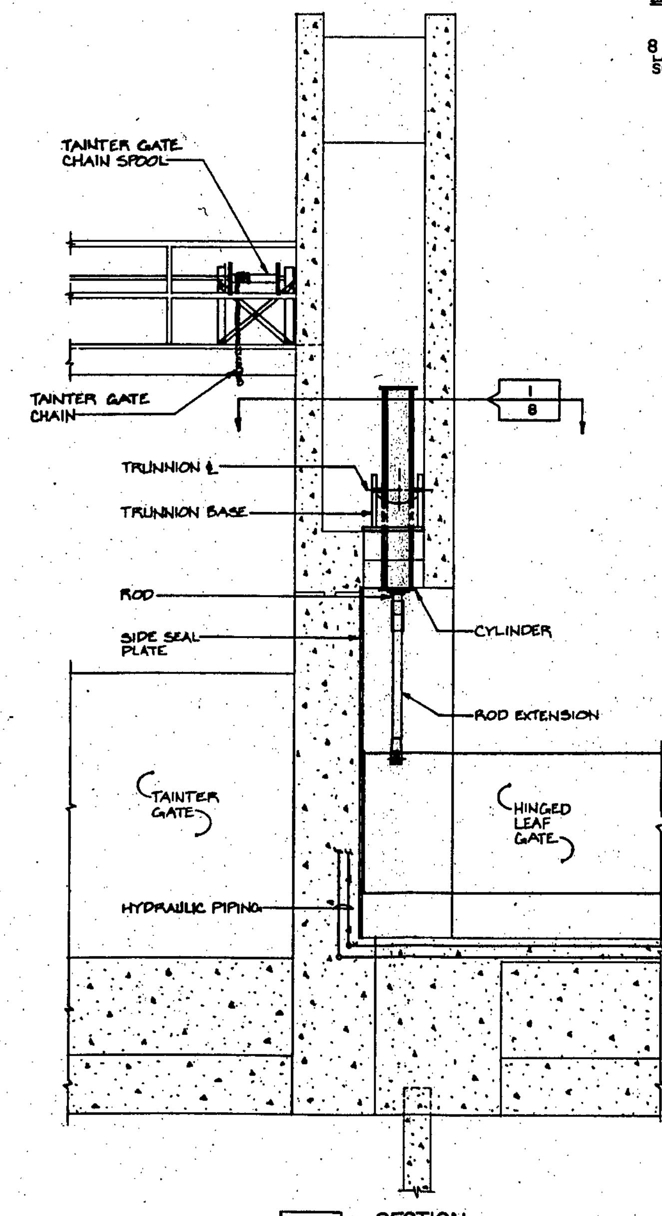
PLA

8
SCALE



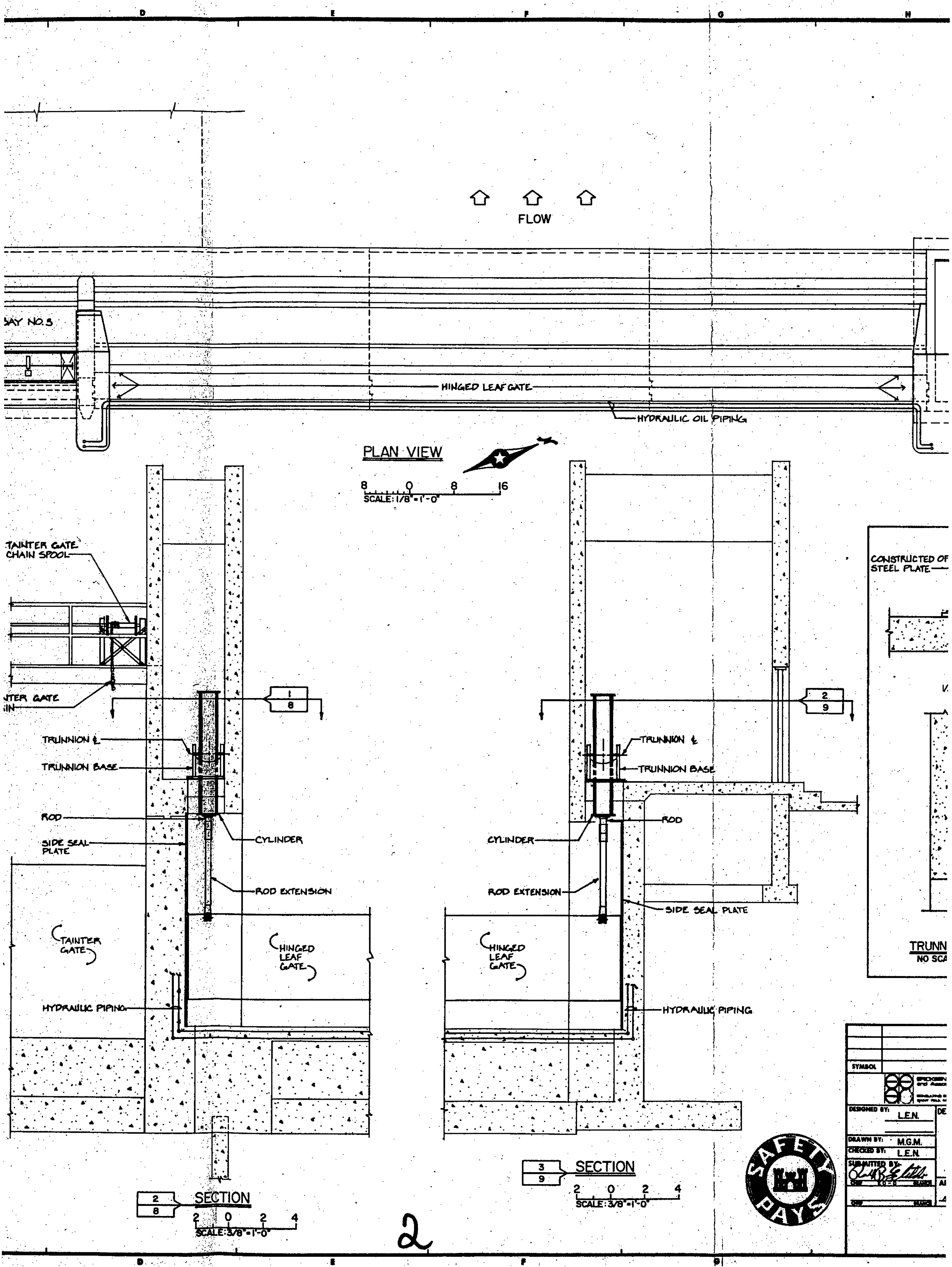
1
8
FIRST FLOOR PLAN

2 0 2 4
SCALE: 3/8"=1'-0"

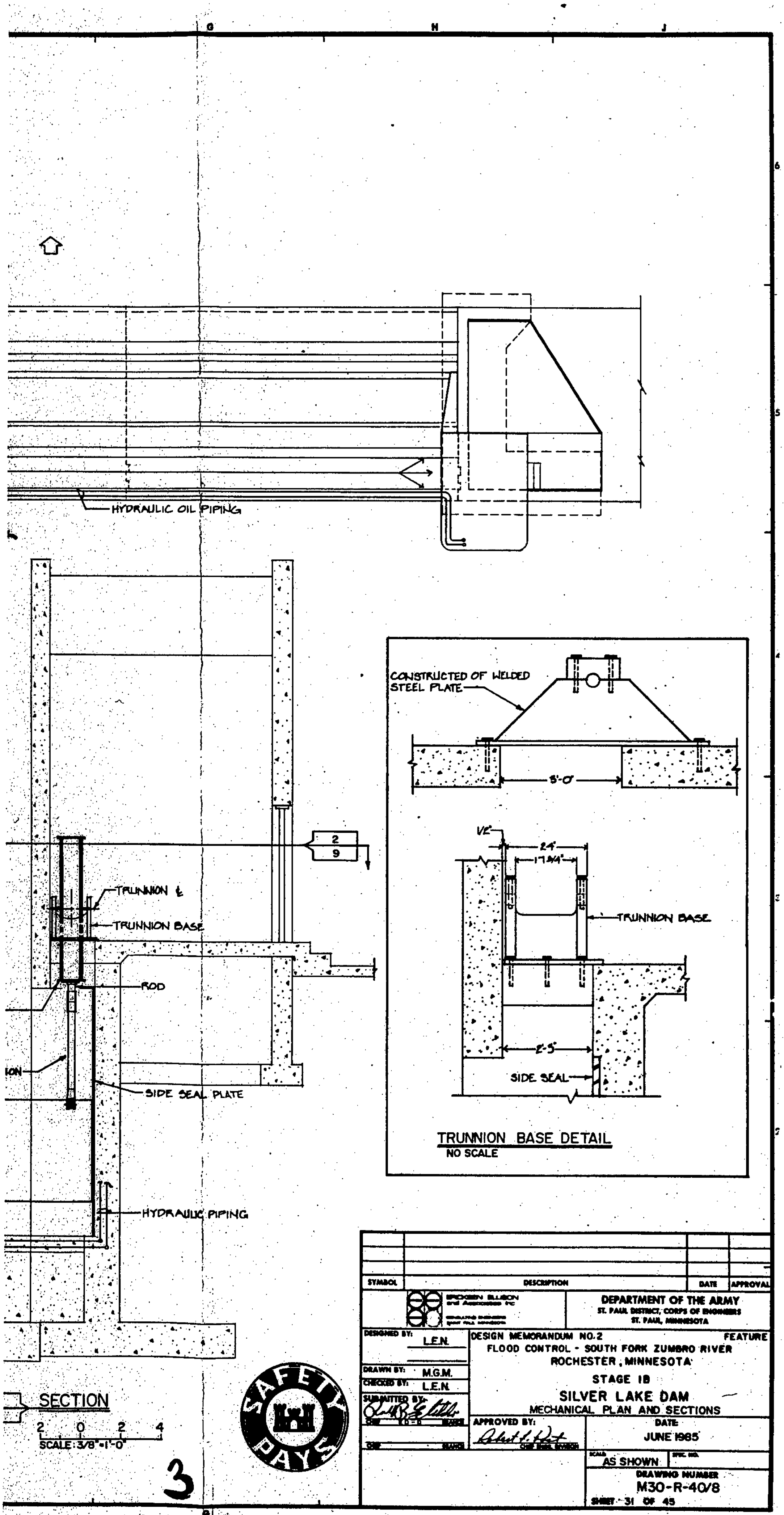


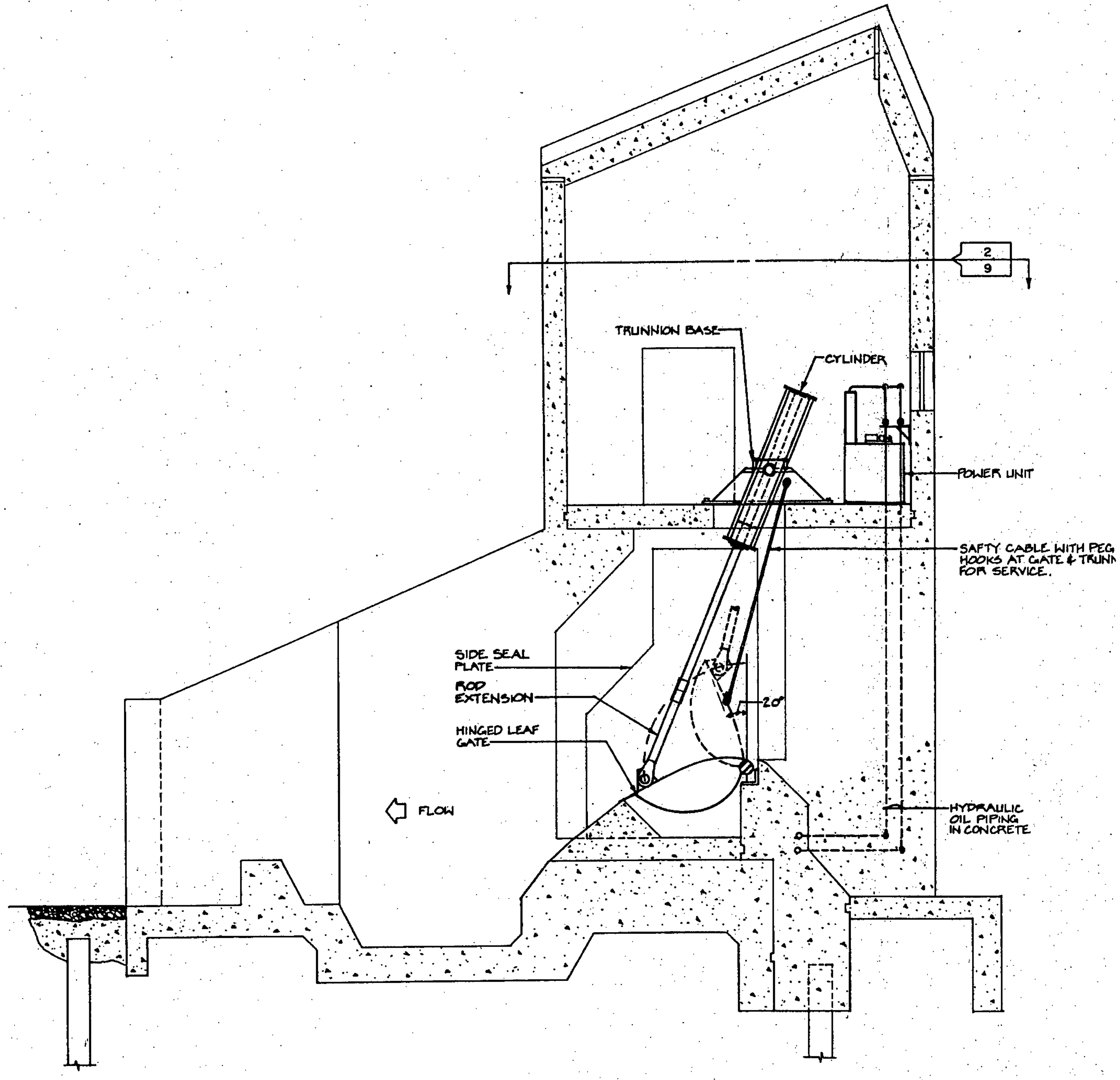
2
8
SECTION

2 0 2 4
SCALE: 3/8"=1'-0"



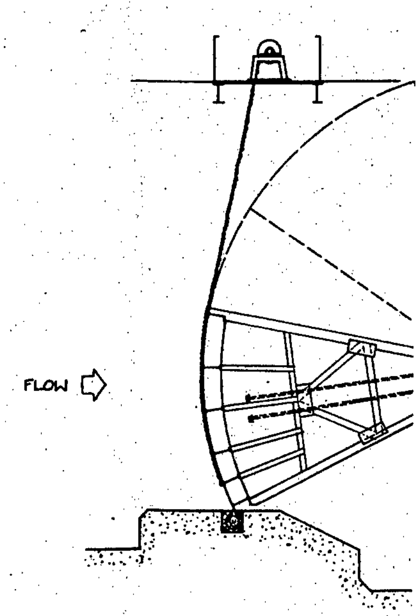
D
E
F
G
H
FLOW
BAY NO.5
HINGED LEAF GATE
HYDRAULIC OIL PIPING
PLAN VIEW
8 0 8 16
SCALE: 1/8"=1'-0"
TAINTER GATE CHAIN SPOOL
TAINTER GATE CHAIN
1
8
TRUNNION ℄
TRUNNION BASE
ROD
SIDE SEAL PLATE
CYLINDER
ROD EXTENSION
TAINTER GATE
HINGED LEAF GATE
HYDRAULIC PIPING
2
8
SECTION
2 0 2 4
SCALE: 3/8"=1'-0"
2
9
TRUNNION ℄
TRUNNION BASE
ROD
CYLINDER
ROD EXTENSION
SIDE SEAL PLATE
HINGED LEAF GATE
HYDRAULIC PIPING
3
9
SECTION
2 0 2 4
SCALE: 3/8"=1'-0"
CONSTRUCTED OF STEEL PLATE
TRUNN
NO SCA
SYMBOL
DESIGNED BY: L.E.N.
DRAWN BY: M.G.M.
CHECKED BY: L.E.N.
SUBMITTED BY:
SAFETY PAYS
2


G
H
J
HYDRAULIC OIL PIPING
TRUNNION ℄
TRUNNION BASE
ROD
SIDE SEAL PLATE
HYDRAULIC PIPING
2
9
CONSTRUCTED OF WELDED STEEL PLATE
5'-0"
1/2"
2'-4"
1'-7 3/4"
TRUNNION BASE
2'-5"
SIDE SEAL
TRUNNION BASE DETAIL
NO SCALE
SECTION
2 0 2 4
SCALE: 3/8"=1'-0"
3
SAFETY PAYS
SYMBOL
DESCRIPTION
DATE
APPROVAL
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
DESIGNED BY: L.E.N.
DRAWN BY: M.G.M.
CHECKED BY: L.E.N.
SUBMITTED BY:
APPROVED BY:
DESIGN MEMORANDUM NO. 2
FEATURE
FLOOD CONTROL - SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
SILVER LAKE DAM
MECHANICAL PLAN AND SECTIONS
DATE
JUNE 1985
SCALE
AS SHOWN
DRAWING NUMBER
M30-R-40/8
SHEET 31 OF 45



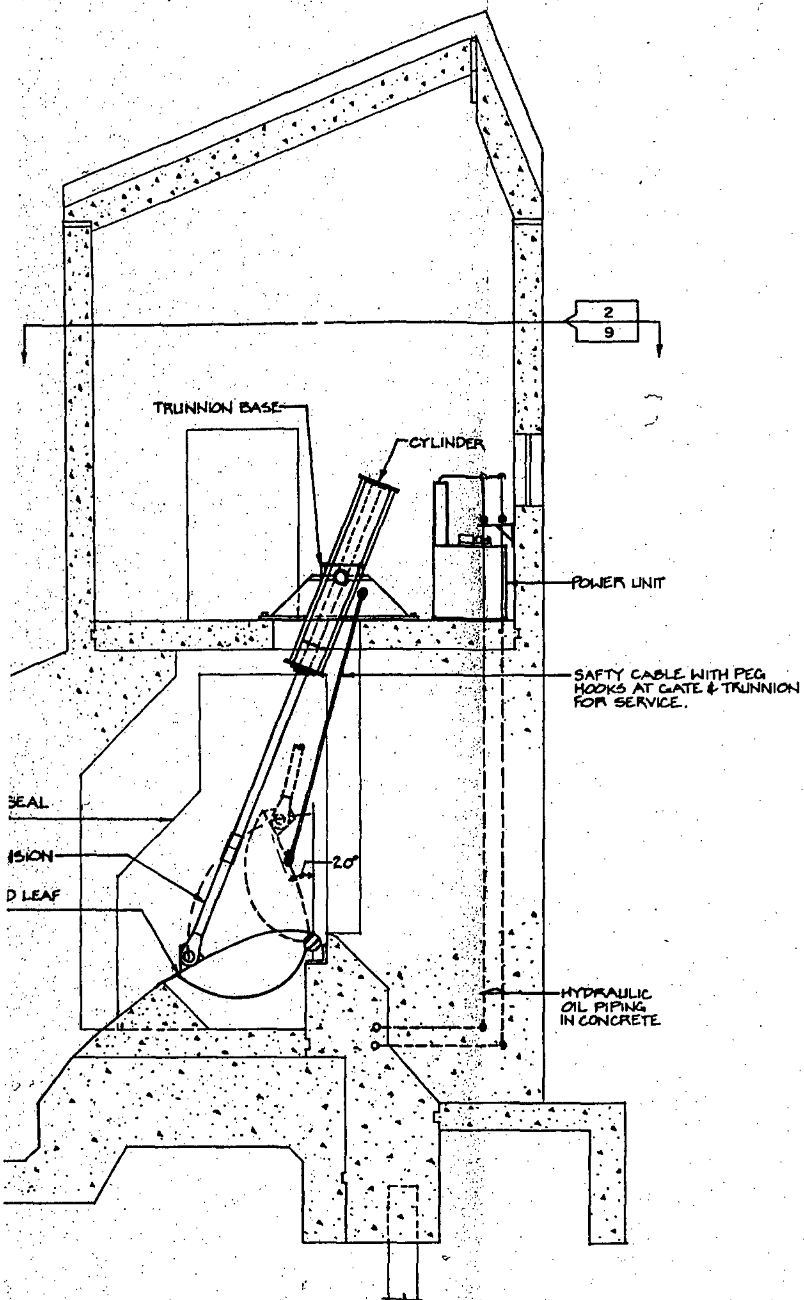
1
9
SECTION

2 0 2 4
SCALE: 3/8"=1'-0"



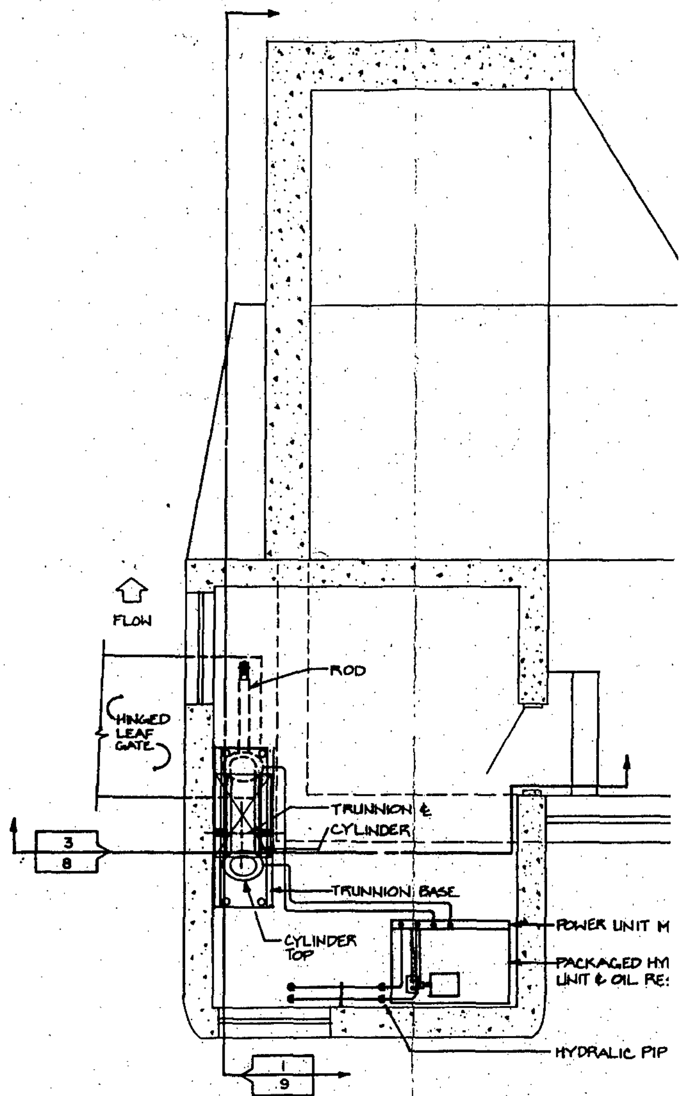
4
8
SECT
NO SCAL

D E F G



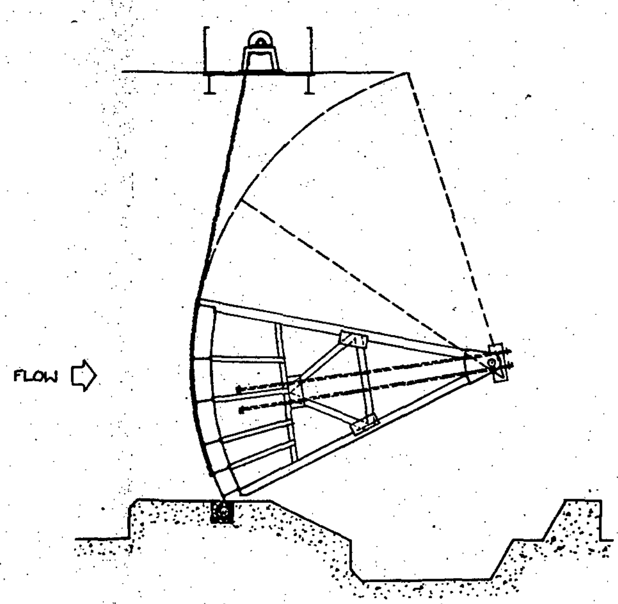
SECTION

2 0 2 4
SCALE: 3/8"=1'-0"



2
8
FIRST FLOOR PLAN-RIGHT ABUTME

2 0 2 4
SCALE: 3/8"=1'-0"



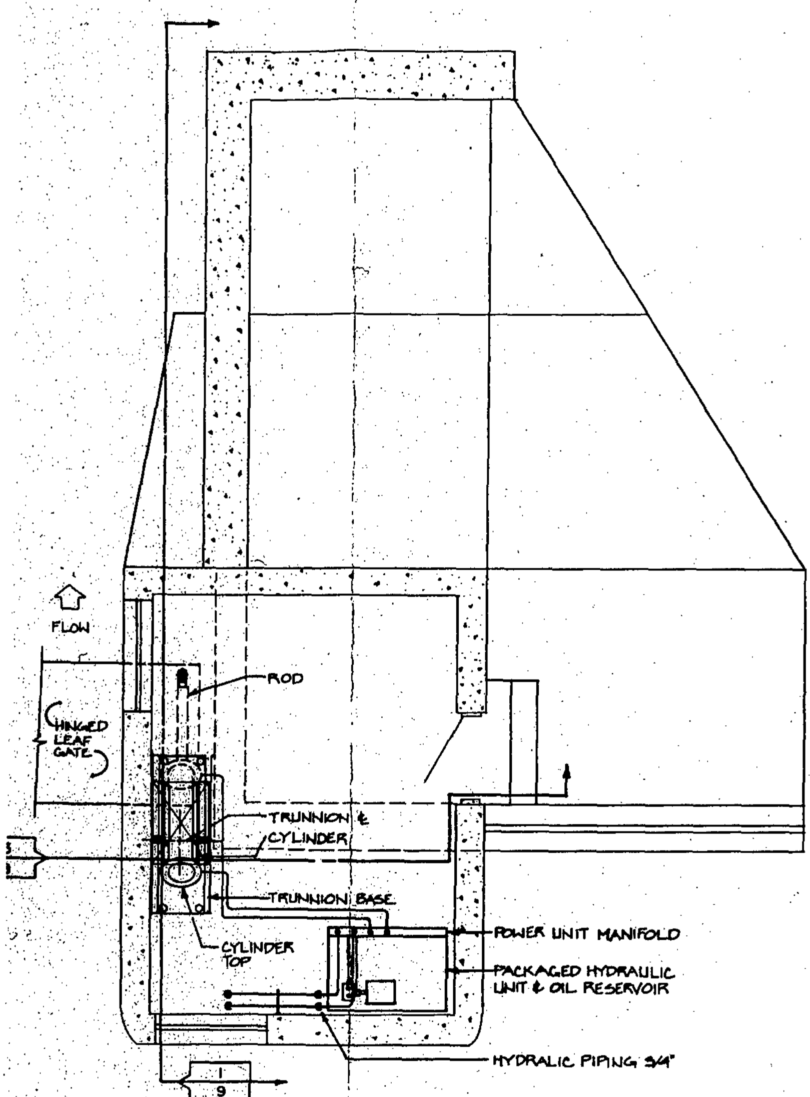
4
8
SECTION
NO SCALE

2

SYMBOL
DESIGNED B
DRAWN BY:
CHECKED BY
SUBMITTED

SAFETY PAYS

C D E F G



2/8 FIRST FLOOR PLAN-RIGHT ABUTMENT

2 0 2 4
SCALE: 3/8"=1'-0"

3

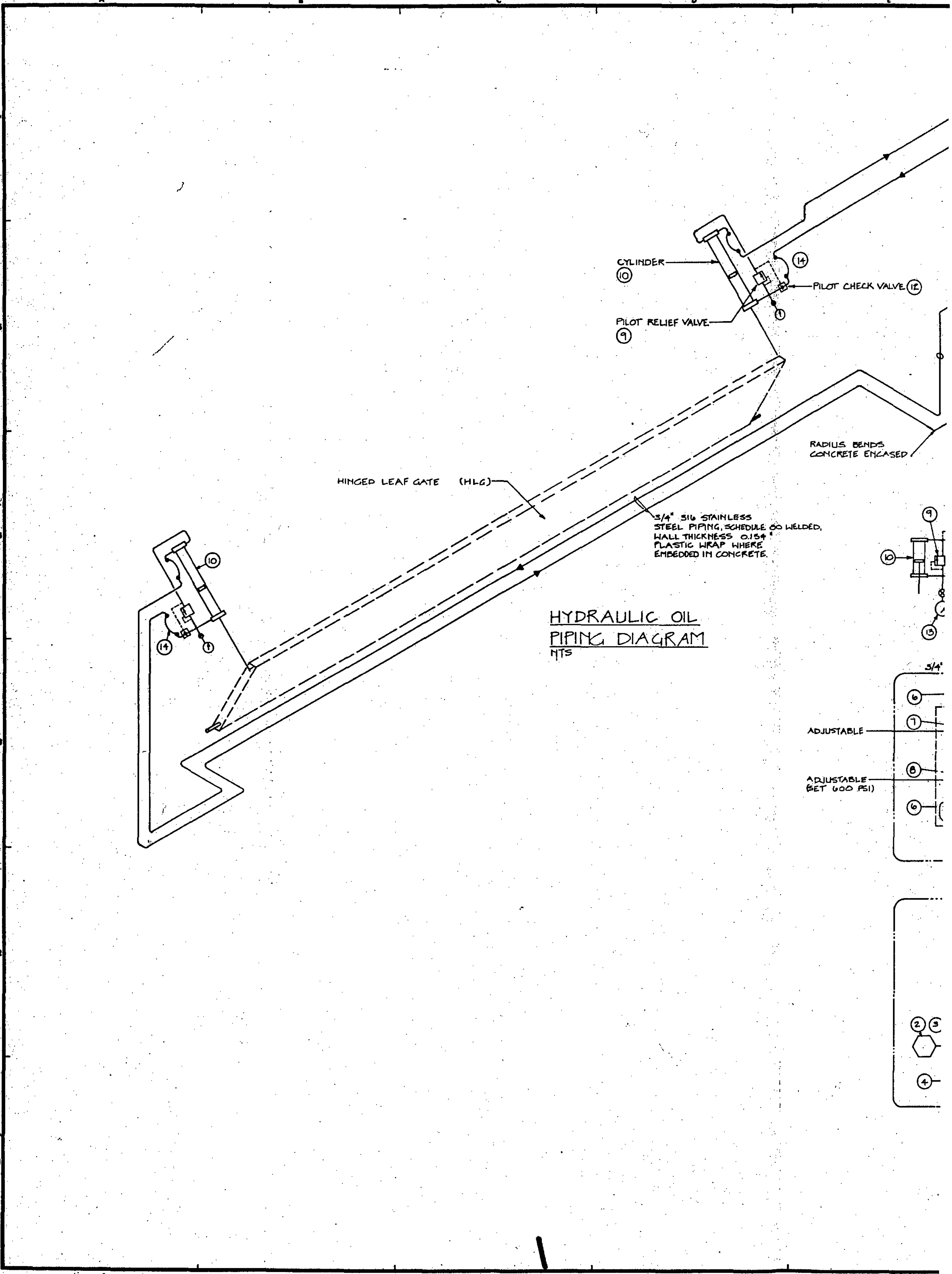
SYMBOL	DESCRIPTION	DATE	APPROVAL

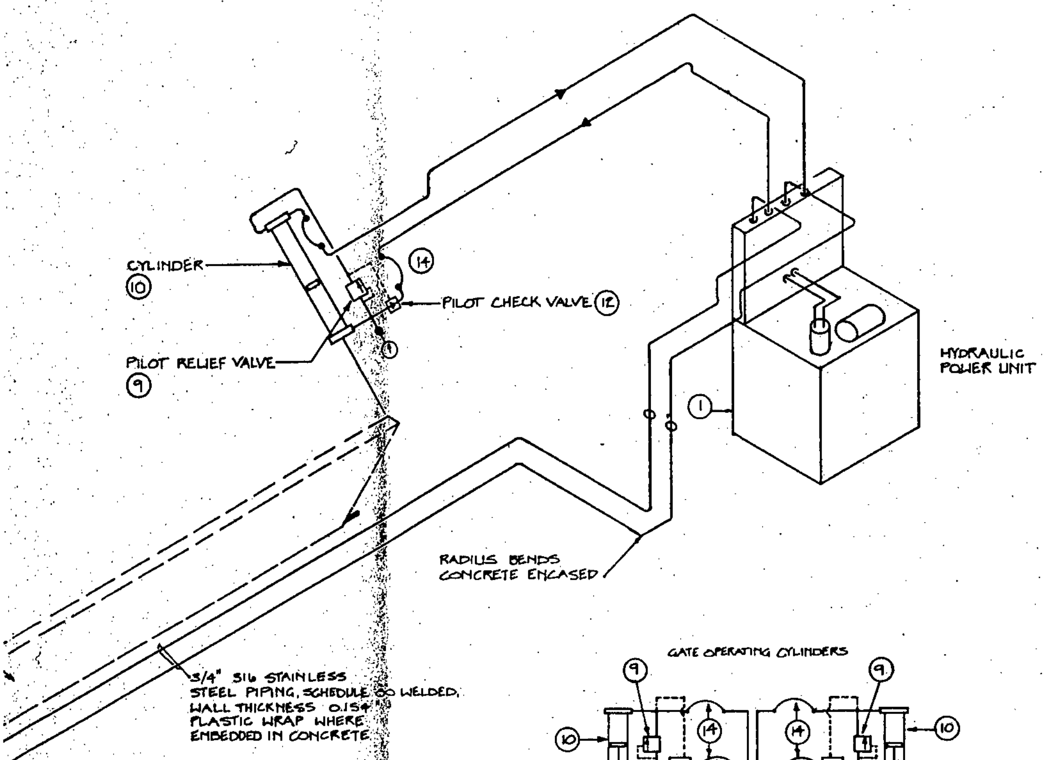
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: L.E.N.
DRAWN BY: M.G.M.
CHECKED BY: L.E.N.
SUBMITTED BY:
APPROVED BY:

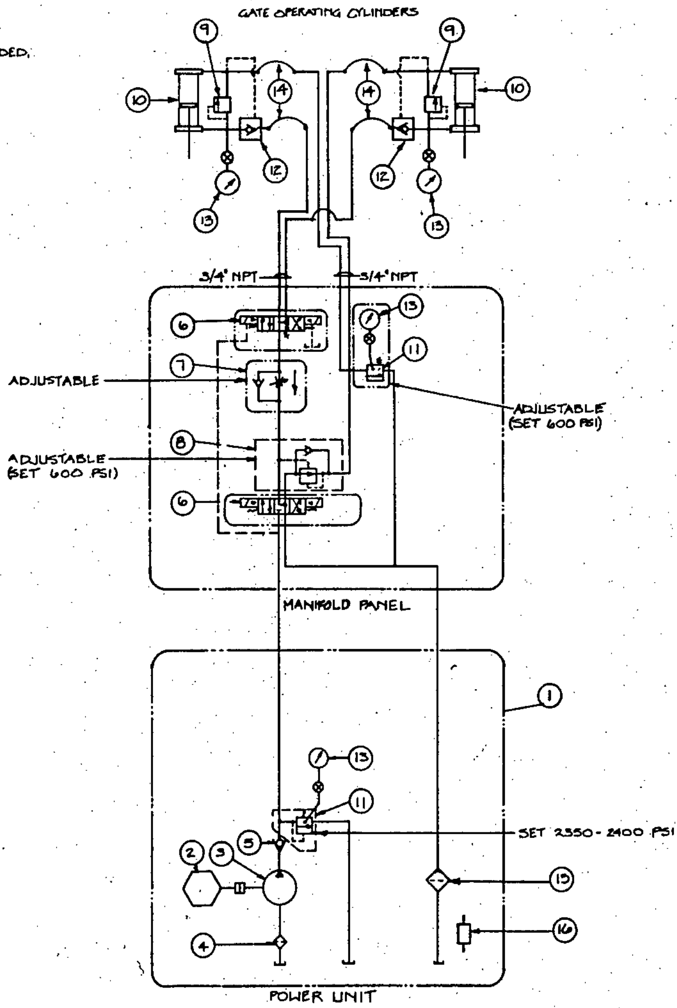
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL - SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM
MECHANICAL PLAN AND SECTIONS

DATE: JUNE 1985
SCALE: AS SHOWN
SPEC NO.
DRAWING NUMBER M30-R-40/9
SHEET 32 OF 45


CYLINDER
10
PILOT CHECK VALVE 12
14
PILOT RELIEF VALVE
9
RADIUS BENDS
CONCRETE ENCASED
HINGED LEAF GATE (HLG)
3/4" 316 STAINLESS STEEL PIPING, SCHEDULE 80 WELDED, WALL THICKNESS 0.154" PLASTIC WRAP WHERE EMBEDDED IN CONCRETE.
HYDRAULIC OIL PIPING DIAGRAM
NTS
ADJUSTABLE
ADJUSTABLE (SET 600 PSI)
3/4"
13



HYDRAULIC OIL PIPING DIAGRAM
NTS



HYDRAULIC EQUIPMENT			
ITEM NO.	QUANT.	DESCRIPTION	REMAR
1	1	RESERVOIR, OIL	30 G
2	1	MOTOR, ELECTRIC	5 HP
3	1	PUMP, HYDRAULIC	2 GP
4	1	FILTER, SUCTION	
5	1	VALVE, CHECK	
6	2	VALVE, DIRECTIONAL	SOLE
7	1	VALVE, FLOW CONTROL	WITH
8	1	VALVE, REDUCING	
9	2	PILOT RELIEF VALVE	
10	2	CYLINDER, HYDRAULIC	10' DI
11	2	VALVE RELIEF	
12	2	PILOT CHECK VALVE	
13	4	GAUGE, PRESSURE	
14	4	LINE, FLEXIBLE	
15	1	RETURN LINE FILTER	
16	1	PROVISION FOR HEATER	

SYMBOLS		
1		OIL RESERVOIR, VENTED
2		PUMP ASSEMBLY - MOTOR
3		PUMP ASSEMBLY - COUPLING & PUMP
4		FILTER, SUCTION
5		CHECK VALVE
6		DIRECTIONAL CONTROL VALVE
7		FLOW CONTROL
8		VALVE REDUCING
9		PILOT RELIEF VALVE
10		HYDRAULIC CYLINDER, DOUBLE ACTING

SYMBOL

DESIGNED BY: L.E.N.

DRAWN BY: S.D.O.

CHECKED BY: L.E.N.

SUBMITTED BY:

SAFETY PAYS

2

ULIC
R UNIT

STABLE
600 PSI)

2350 - 2400 PSI

HYDRAULIC EQUIPMENT SCHEDULE

ITEM NO.	QUANT.	DESCRIPTION	REMARKS
1	1	RESERVOIR, OIL	50 GAL.
2	1	MOTOR, ELECTRIC	5 HP
3	1	PUMP, HYDRAULIC	2 GPM
4	1	FILTER, SUCTION	
5	1	VALVE, CHECK	
6	2	VALVE, DIRECTIONAL	SOLENOID OPERATED
7	1	VALVE, FLOW CONTROL	WITH CHECK
8	1	VALVE, REDUCING	
9	2	PILOT RELIEF VALVE	
10	2	CYLINDER, HYDRAULIC	10" DIAMETER, 6'-0" STROKE
11	2	VALVE RELIEF	
12	2	PILOT CHECK VALVE	
13	4	GAUGE, PRESSURE	
14	4	LINE, FLEXIBLE	
15	1	RETURN LINE FILTER	
16	1	PROVISION FOR HEATER	

SYMBOLS

1		OIL RESERVOIR, VENTED	11		RELIEF VALVE, ADJUSTABLE
2		PUMP ASSEMBLY - MOTOR	12		PILOT CHECK VALVE
3		PUMP ASSEMBLY - COUPLING & PUMP	13		PRESSURE GAUGE W/SHUT OFF VALVE
4		FILTER, SUCTION	14		LINE, FLEXIBLE
5		CHECK VALVE	15		RETURN LINE FILTER
6		DIRECTIONAL CONTROL VALVE			LINE, PILOT
7		FLOW CONTROL			ENCLOSURE OUTLINE
8		VALVE REDUCING			LINE, JOINING
9		PILOT RELIEF VALVE			LINE, CROSSING
10		HYDRAULIC CYLINDER, DOUBLE ACTING			LINE, WORKING

SYMBOL	DESCRIPTION	DATE	APPROVAL

ERICKSEN ELLISON and Associates Inc
CONSULTING ENGINEERS
SAINT PAUL MINNESOTA

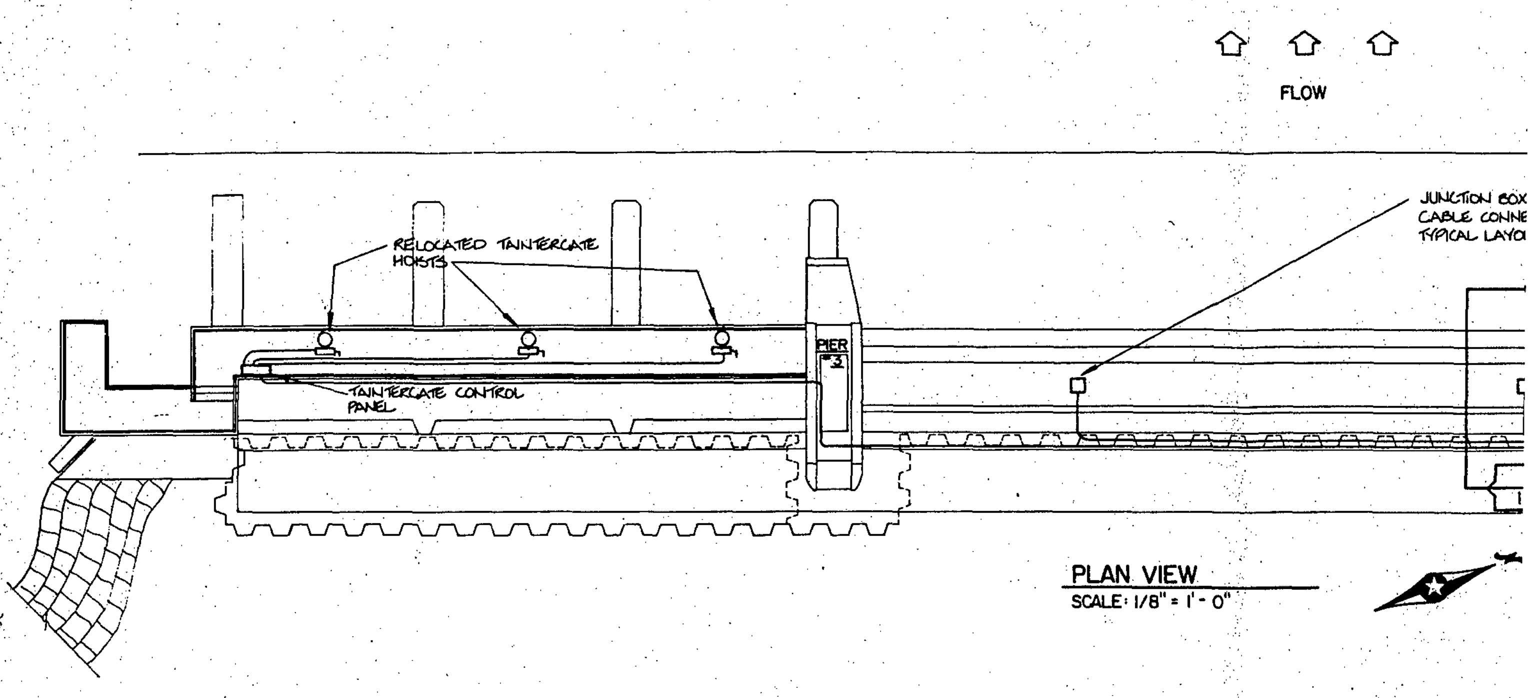
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: L.E.N.
DRAWN BY: S.D.O.
CHECKED BY: L.E.N.
SUBMITTED BY:

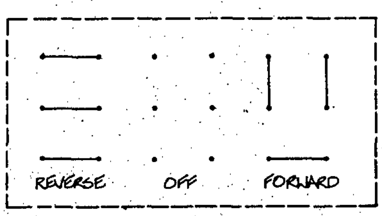
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL - SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM
MECHANICAL

APPROVED BY:
DATE: JUNE 1985
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER M30-R-40/10
SHEET 33 OF 45

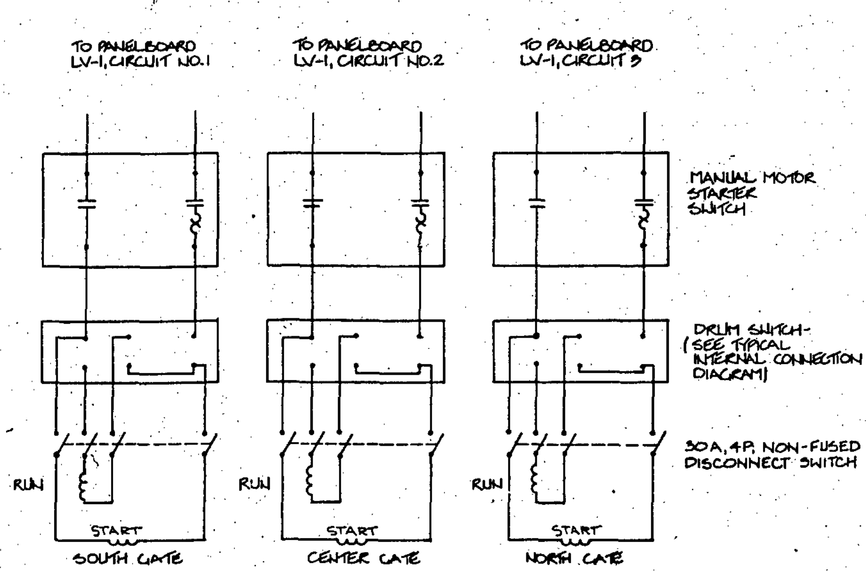
3



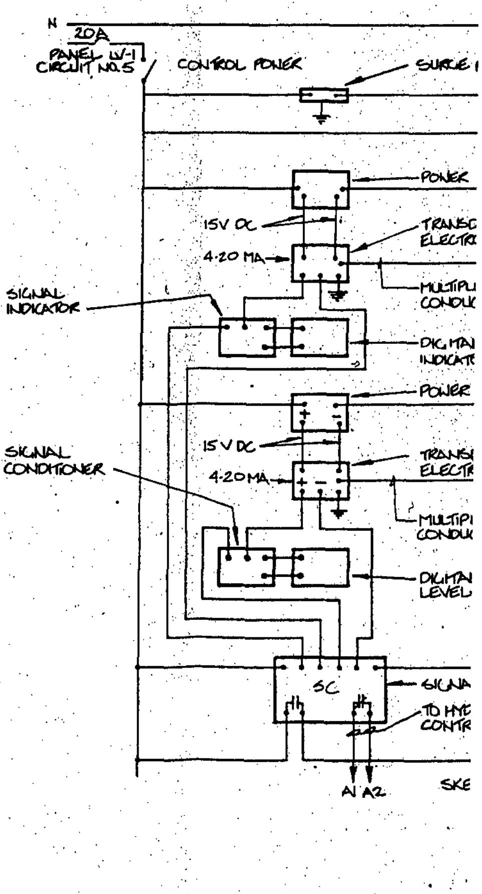
PLAN VIEW
SCALE: 1/8" = 1'- 0"



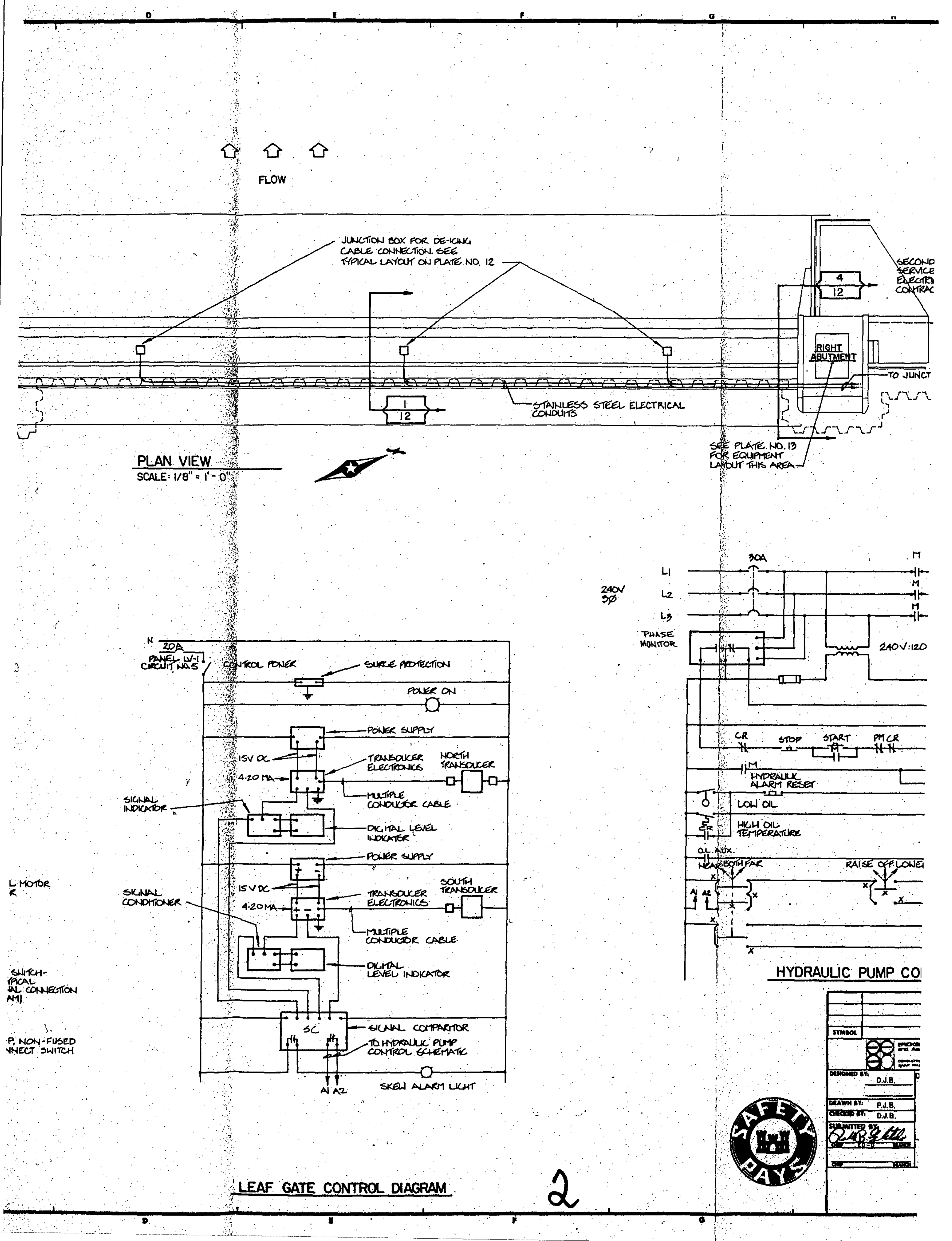
TYPICAL INTERNAL CONNECTION DIAGRAM OF DRUM SWITCH



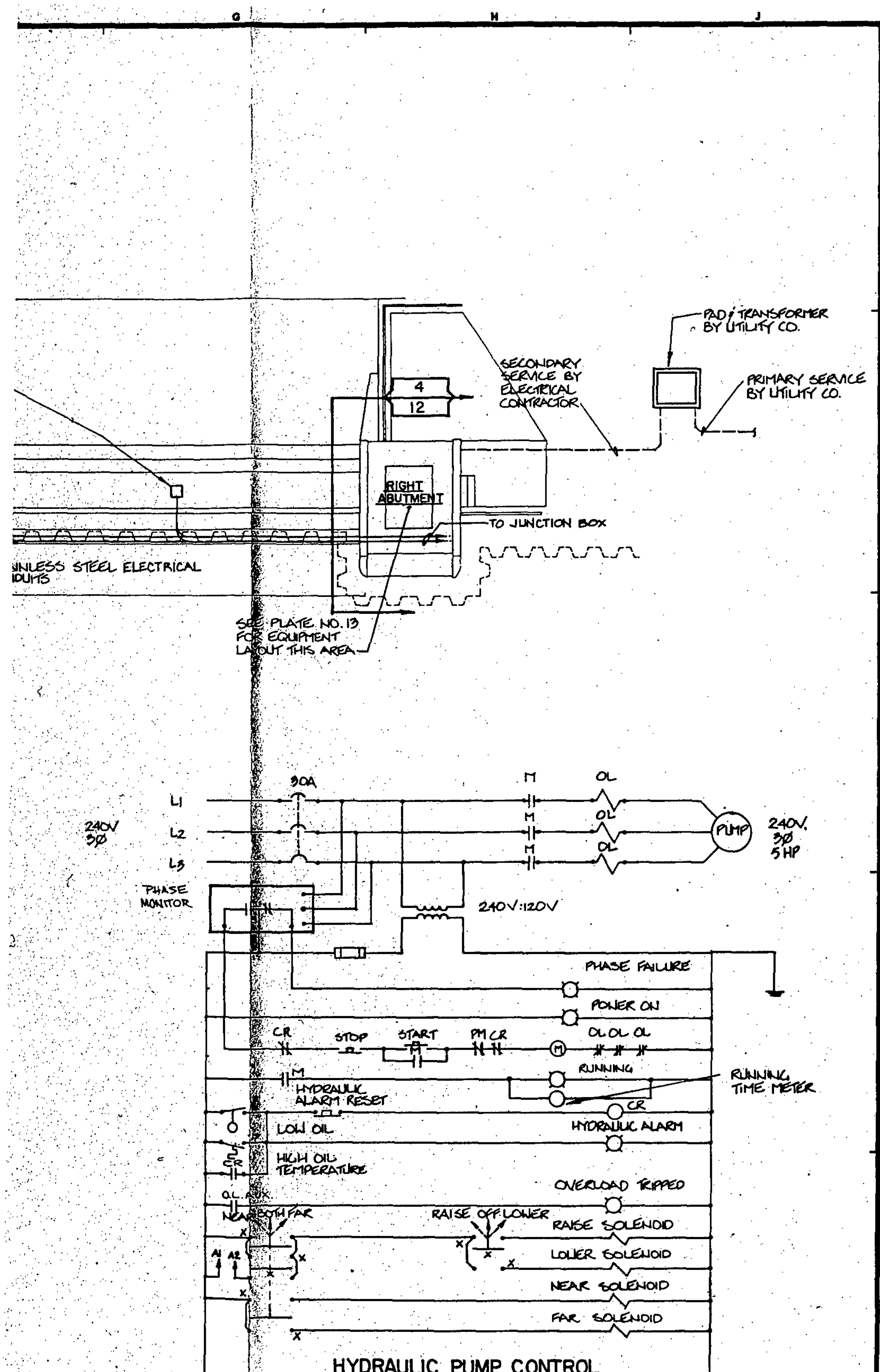
TAINTERGATE CONTROL DIAGRAM



LEAF GATE CONTROL D



FLOW
JUNCTION BOX FOR DE-ICING CABLE CONNECTION. SEE TYPICAL LAYOUT ON PLATE NO. 12
STAINLESS STEEL ELECTRICAL CONDUITS
RIGHT ABUTMENT
TO JUNCT
SEE PLATE NO. 13 FOR EQUIPMENT LAYOUT THIS AREA
SECOND SERVICE ELECTRI CONTRAC
PLAN VIEW
SCALE: 1/8" = 1'-0"
N
20A
PANEL LV-1 CIRCUIT NO. 5
CONTROL POWER
SURGE PROTECTION
POWER ON
POWER SUPPLY
15V DC
4-20 MA
TRANSDUCER ELECTRONICS
NORTH TRANSDUCER
MULTIPLE CONDUCTOR CABLE
SIGNAL INDICATOR
DIGITAL LEVEL INDICATOR
SOUTH TRANSDUCER
SIGNAL CONDITIONER
SC
SIGNAL COMPARITOR
TO HYDRAULIC PUMP CONTROL SCHEMATIC
SKEW ALARM LIGHT
A1 A2
LEAF GATE CONTROL DIAGRAM
L MOTOR
SWITCH-TYPICAL CONNECTION
NON-FUSED DISCONNECT SWITCH
30A
L1
L2
L3
240V 3Ø
PHASE MONITOR
240V:120
CR
STOP
START
PM CR
M
HYDRAULIC ALARM RESET
LOW OIL
HIGH OIL TEMPERATURE
O.L. AUX.
NEAR BOTH FAR
RAISE OFF LOWER
HYDRAULIC PUMP CO
SYMBOL
DESIGNED BY: D.J.B.
DRAWN BY: P.J.B.
CHECKED BY: D.J.B.
SUBMITTED BY:
SAFETY PAYS
2



HYDRAULIC PUMP CONTROL

SYMBOL	DESCRIPTION	DATE	APPROVAL

Ericksen Ellison and Associates Inc

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

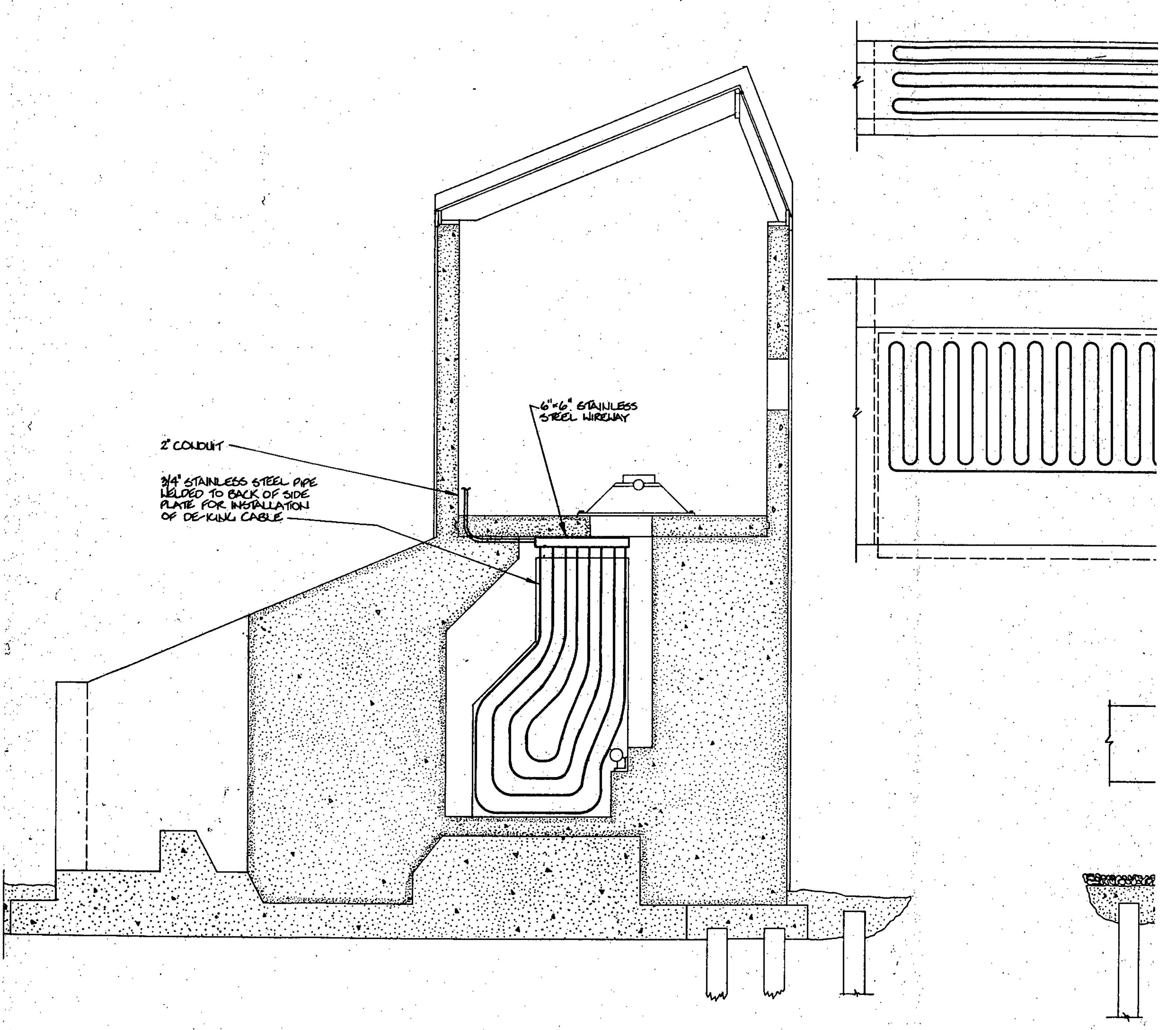
DESIGNED BY: D.J.B.
DRAWN BY: P.J.B.
CHECKED BY: D.J.B.
SUBMITTED BY:

DESIGN MEMORANDUM NO.2 FEATURE
FLOOD CONTROL - SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SILVER LAKE DAM

APPROVED BY:
DATE: JUNE 1985
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-40/11
SHEET 34 OF 45

SAFETY PAYS

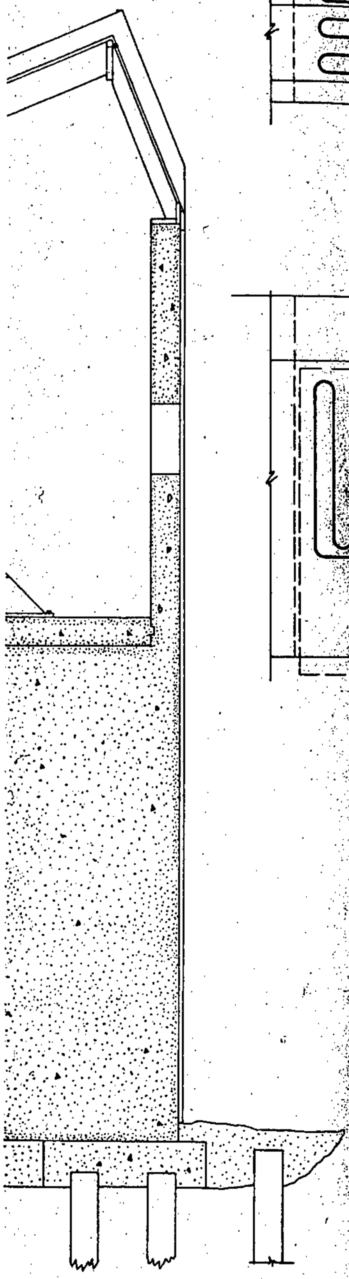
3

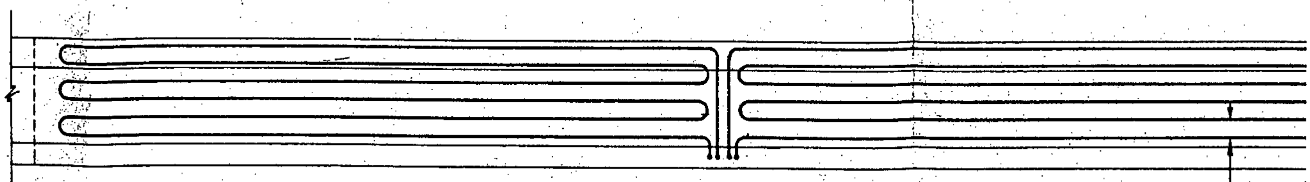


SECTION 4/12

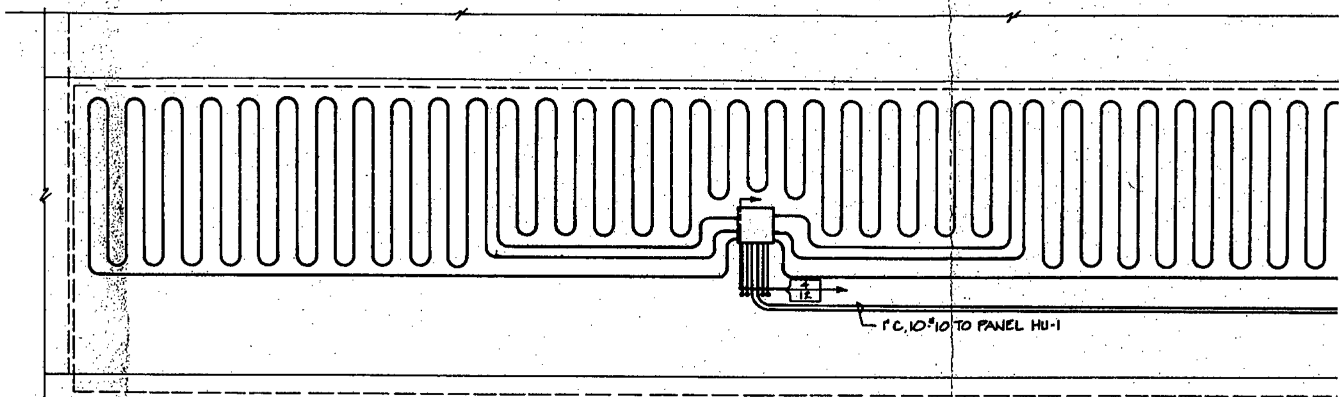
2 0 2 4 6

3/8" = 1'-0"

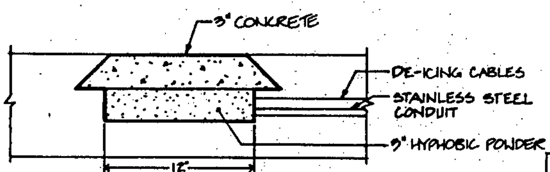




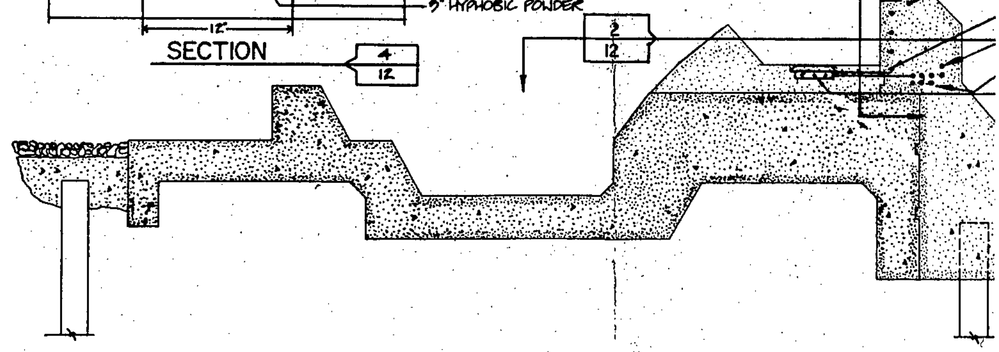
DE-ICING CABLE LAYOUT AT CREST RISER 3/12
SCALE: 3/8" = 1'-0"
(TYPICAL FOR THREE PANELS)



DE-ICING CABLE LAYOUT AT DECK 2/12
SCALE: 3/8" = 1'-0"
TYPICAL OF THREE PANELS



SECTION 4/12



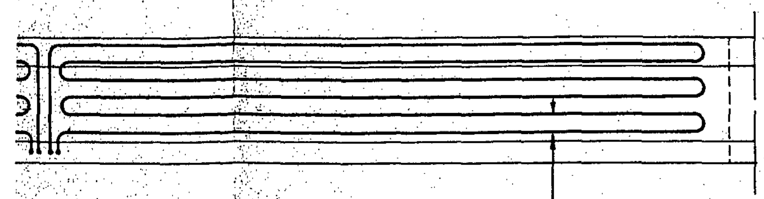
SECTION 1/12

2 0 2 4 6
3/8" = 1'-0"

SYMBOL	
DESIGNED BY: D.J.B.	DESIG... F...
DRAWN BY: P.J.B.	
CHECKED BY: D.J.B.	
SUBMITTED BY:	APPR...

SAFETY PAYS

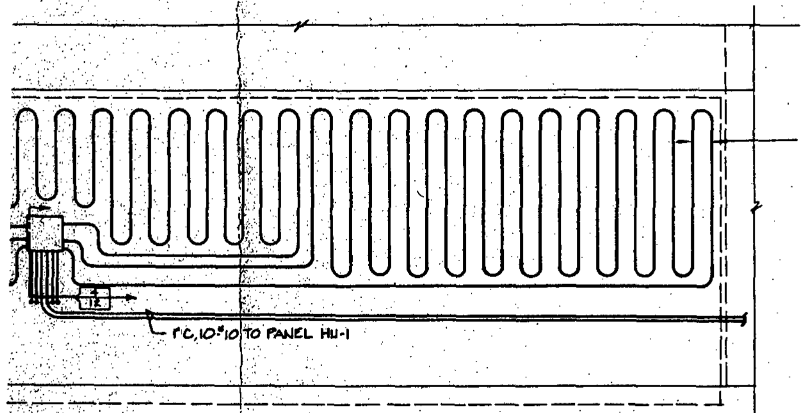
2



AYOUT AT CREST RISER | 3/12

3/8" = 1'-0"

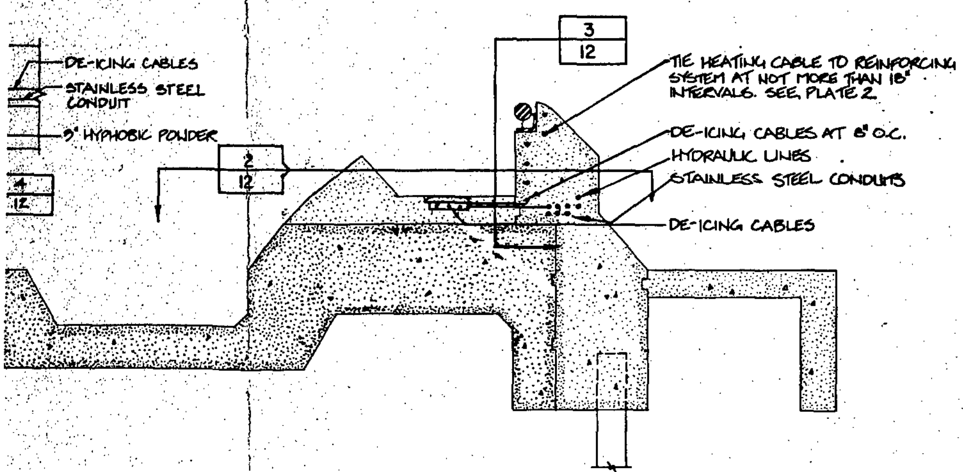
)R THREE PANELS)



: LAYOUT AT DECK | 2/12

8" = 1'-0"

HREE PANELS



SECTION | 1/12

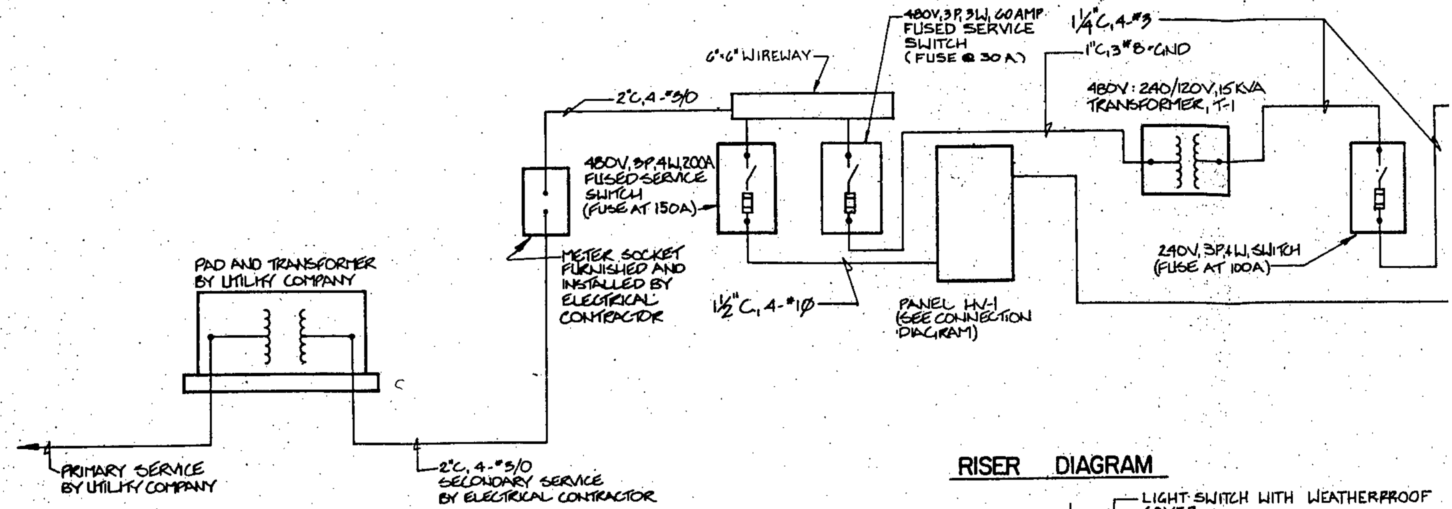
2 0 2 4 6

3/8" = 1'-0"

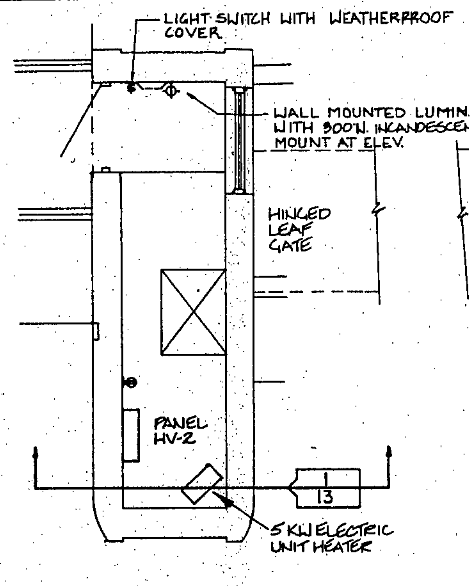
3

SYMBOL	DESCRIPTION	DATE	APPROVAL

ERICKSEN ELLISON and Associates Inc. Consulting Engineers Saint Paul, Minnesota	DEPARTMENT OF THE ARMY ST. PAUL DISTRICT, CORPS OF ENGINEERS ST. PAUL, MINNESOTA
DESIGNED BY: D.J.B. DRAWN BY: P.J.B. CHECKED BY: D.J.B. SUBMITTED BY:	DESIGN MEMORANDUM NO. 2 FEATURE FLOOD CONTROL - SOUTH FORK ZUMBRO RIVER ROCHESTER, MINNESOTA STAGE 1B SILVER LAKE DAM
APPROVED BY:	DATE: JUNE 1985
	SCALE: AS SHOWN
	DRAWING NUMBER M30-R-40/12 SHEET 35 OF 45

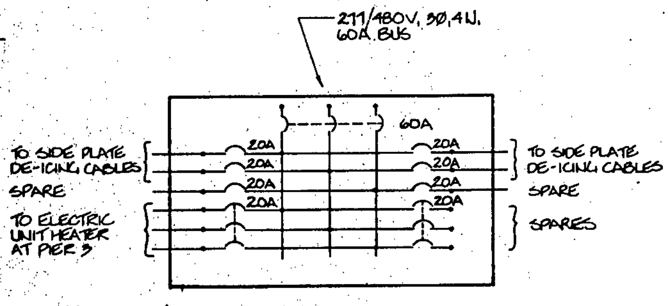


RISER DIAGRAM

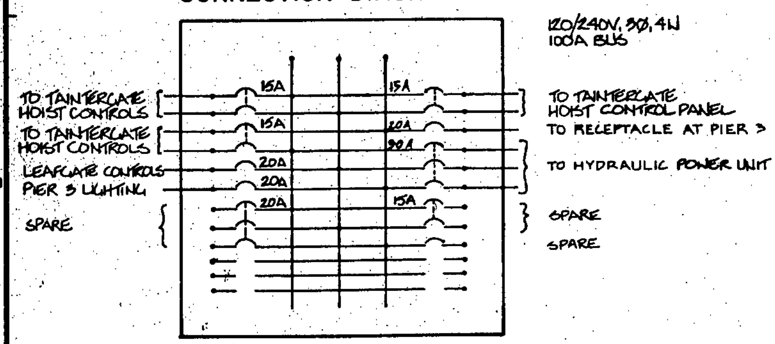


PIER 3 PLAN

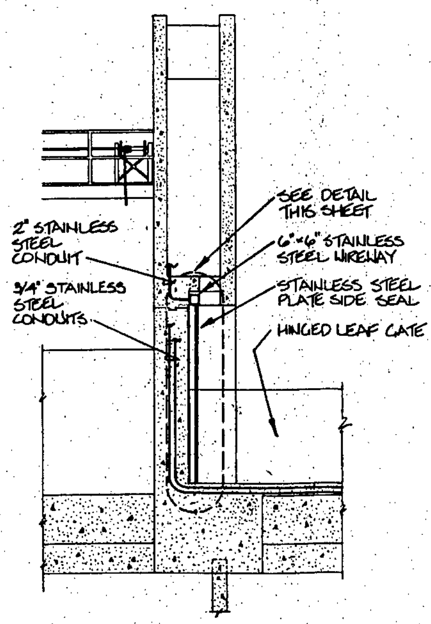
2 0 2 4 6
SCALE: 3/8" = 1'- 0"

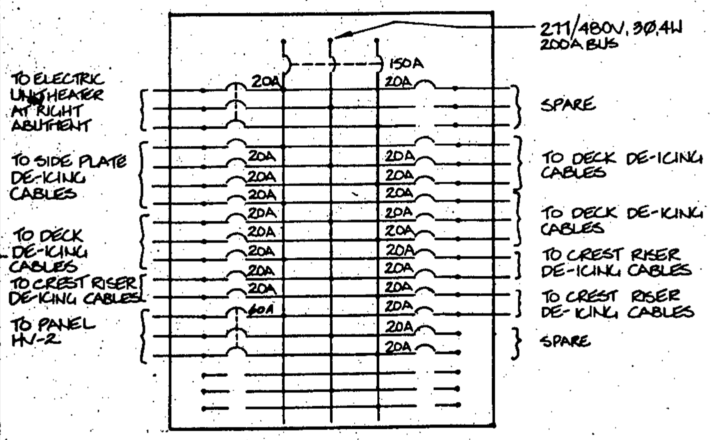


PANEL HV-2
CONNECTION DIAGRAM



PANEL LV-1
CONNECTION DIAGRAM

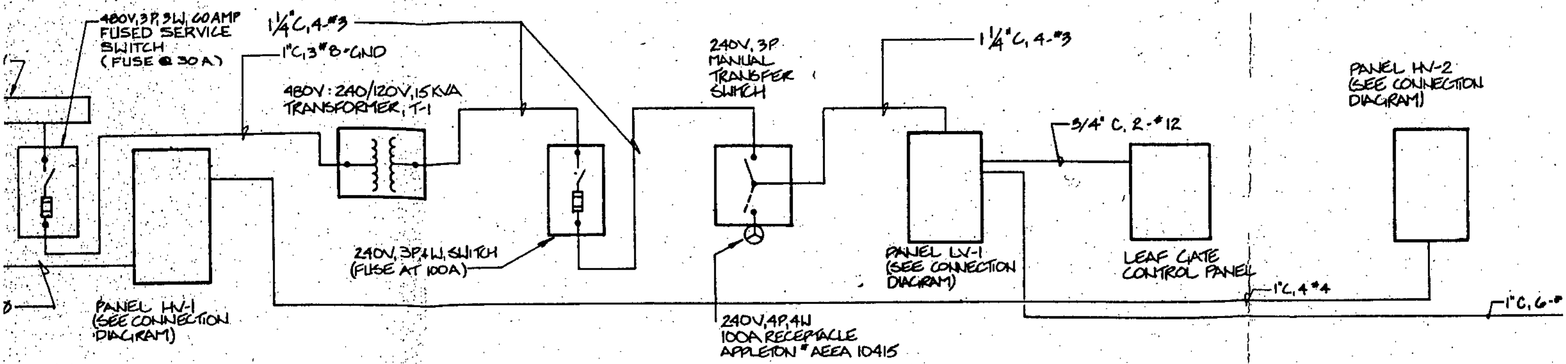




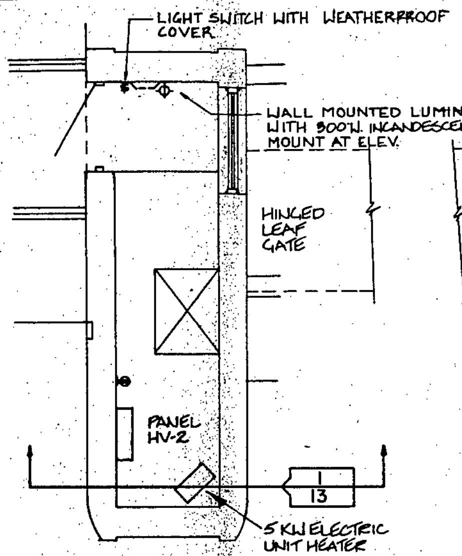
PANEL HV-1
CONNECTION DIAGRAM

1
13
SECTION

4 2 0 2 4 6 8
SCALE: 3/16" = 1'-0"

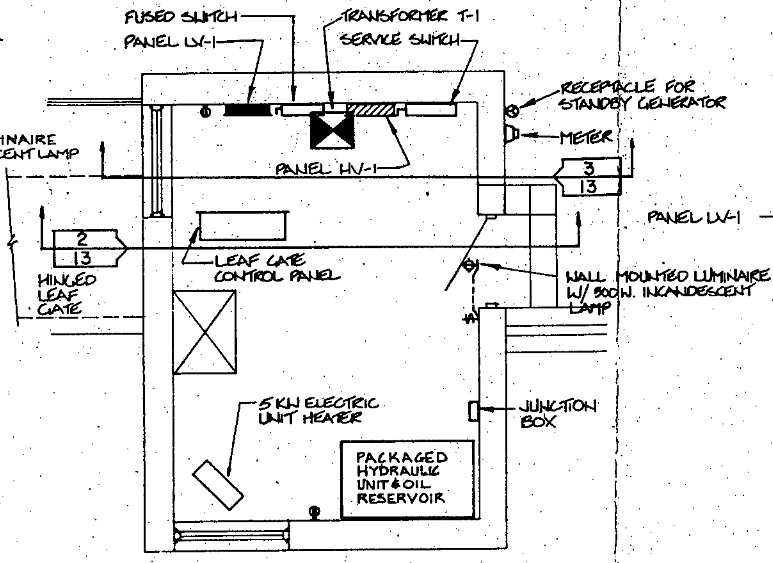


RISER DIAGRAM



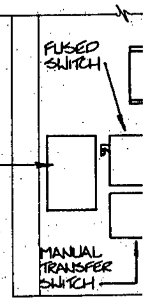
PIER 3 PLAN

2 0 2 4 6
SCALE: 3/8" = 1'-0"



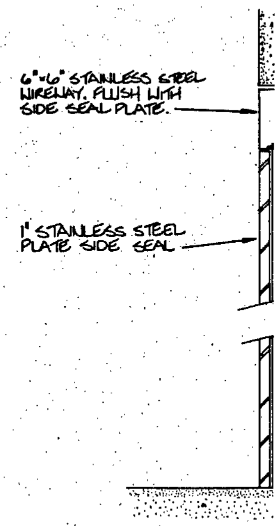
RIGHT ABUTMENT PLAN

2 0 2 4 6
SCALE: 3/8" = 1'-0"

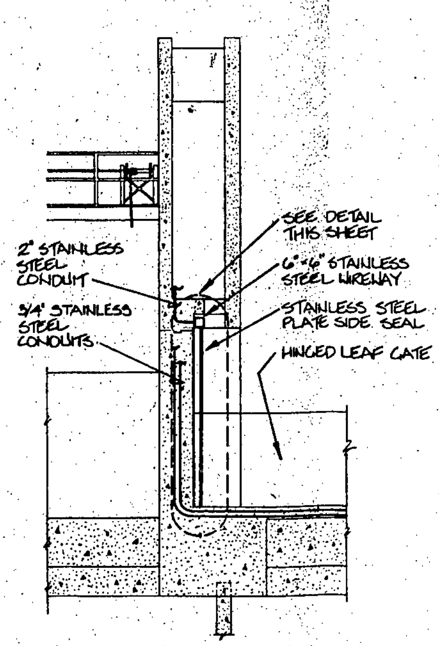


RIGHT ABU

2 0
SCALE:

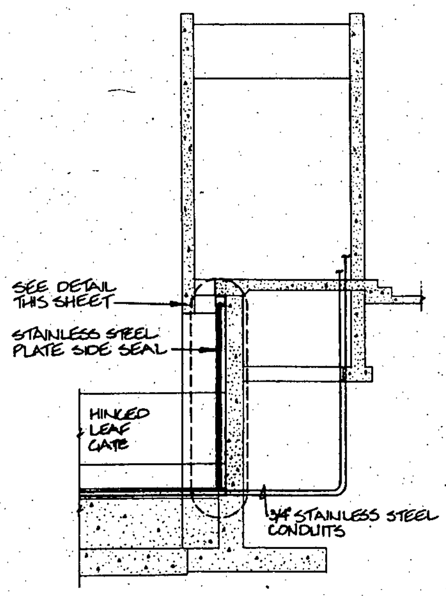


DETAI
OPPOSIT



1/13 SECTION

4 2 0 2 4 6 8
SCALE: 3/16" = 1'-0"



2/13 SECTION

4 2 0 2 4 6 8
SCALE: 3/16" = 1'-0"

2

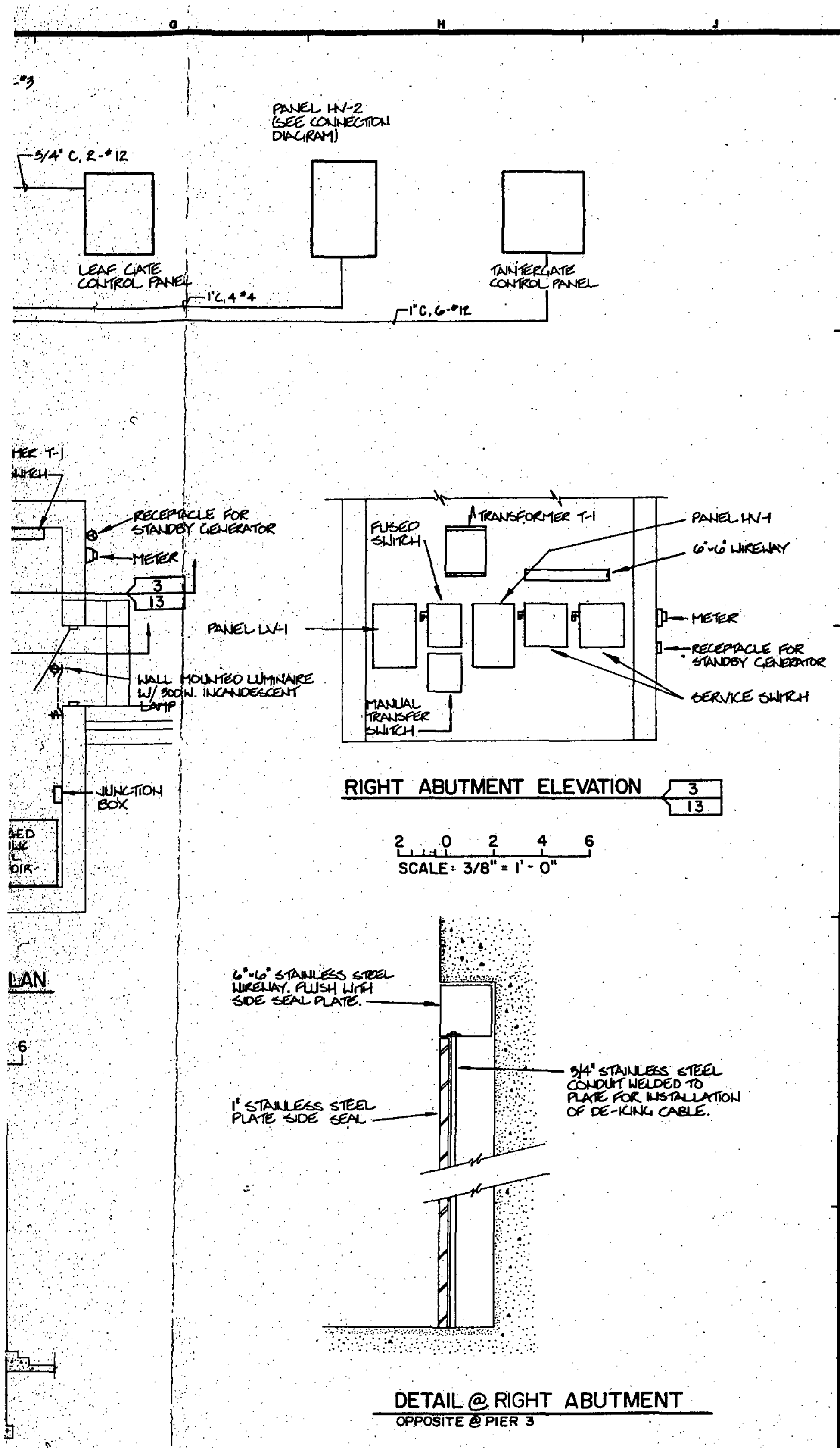
SYMBOL

DESIGNED BY: D.J.B

DRAWN BY: P.J.B.

CHECKED BY: D.J.B.

SUBMITTED BY:



SYMBOL	DESCRIPTION	DATE	APPROVAL

BRICKSEN ELLISON and Associates Inc

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: D.J.B.
DRAWN BY: P.J.B.
CHECKED BY: D.J.B.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL - SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
SILVER LAKE DAM

APPROVED BY:

DATE: JUNE 1985

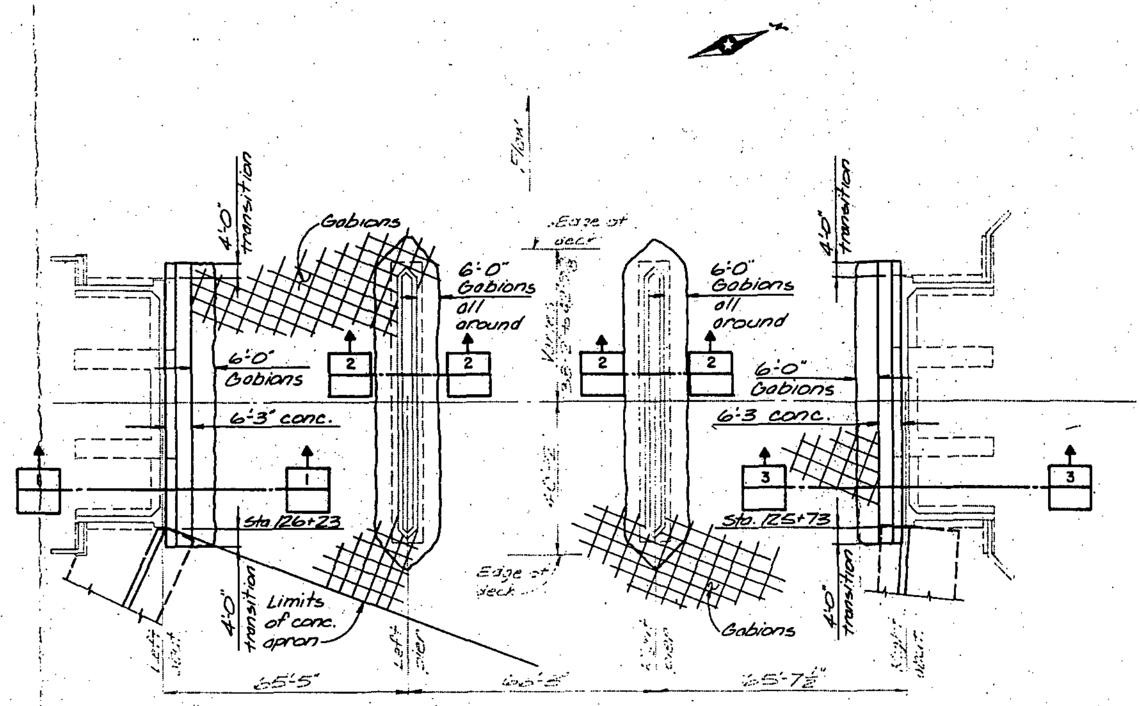
SCALE: AS SHOWN

DRAWING NUMBER: M30-R-40/13

SHEET 36 OF 45

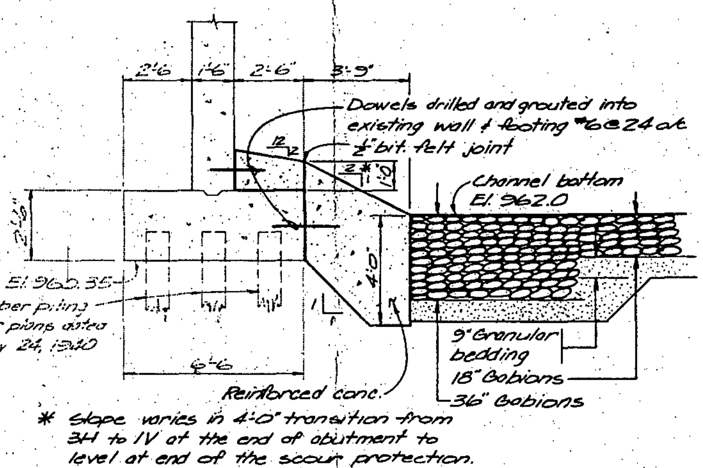
3

SAFETY PAYS



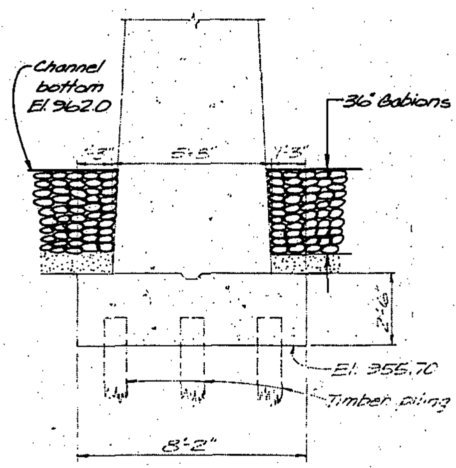
PLAN VIEW

20 0 20 40
SCALE IN FEET



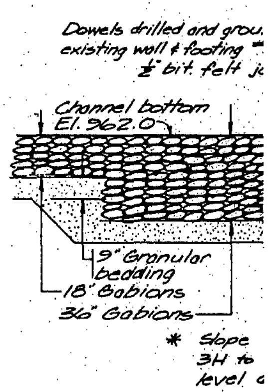
SECTION 1
LEFT ABUTMENT

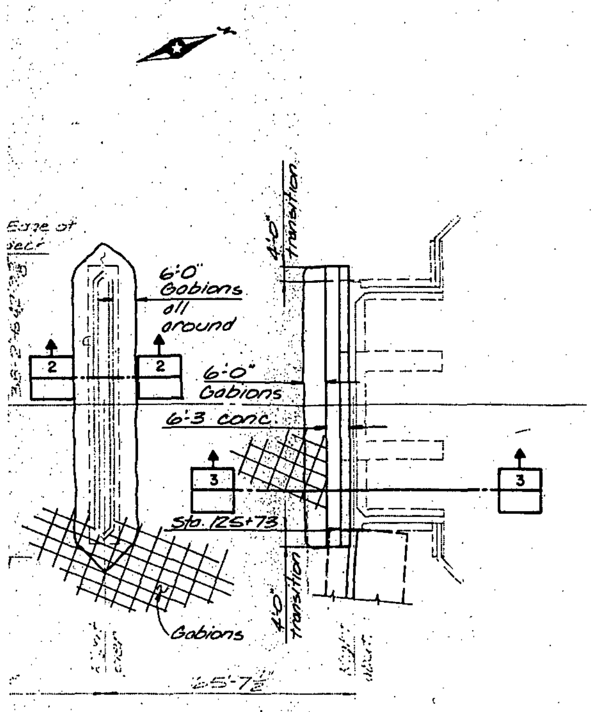
2 0 2 4 6
$\frac{3}{8}$" = 1'-0"



SECTION 2
(2) PIERS

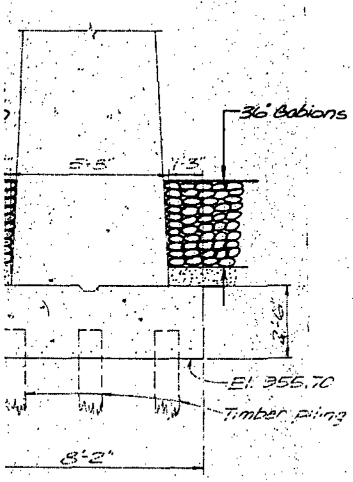
2 0 2 4 6
$\frac{3}{8}$" = 1'-0"





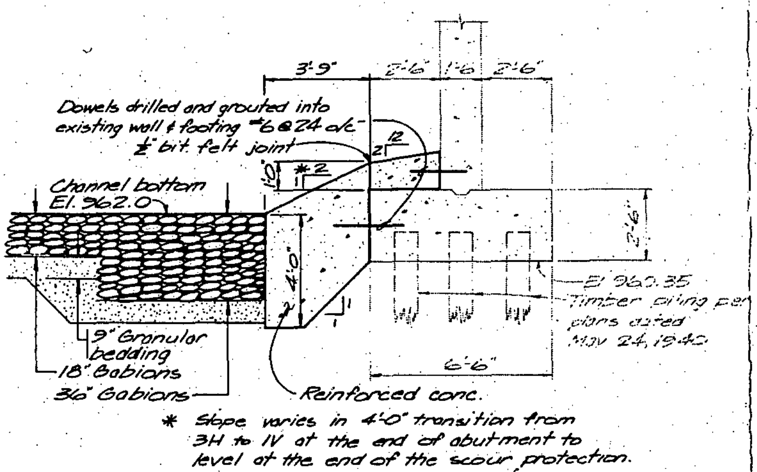
W

20 40
FEET



ION 2
ERS

2 0 2 4 6
$\frac{3}{8}$" = 1'-0"



* Slope varies in 4'-0" transition from 3H to 1V at the end of abutment to level at the end of the scour protection.

SECTION 3
RIGHT ABUTMENT

2 0 2 4 6
$\frac{3}{8}$" = 1'-0"

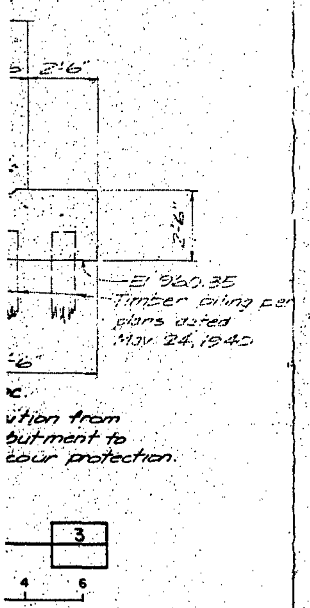
SYMBOL	DESCRIP

WHKS — Professional Engineers & Planners
Mason City, Ia. – Rochester, Minn. – Dubuque, Ia

DESIGNED BY: J.A.J.
DRAWN BY: D.L.E./K.R.R
CHECKED BY: J.D.S./D.O
SUBMITTED BY:
CHIEF ED-D BRANCH
CHIEF ED-SH BRANCH

DESIGN MEMORA
FLOOD
BROADWAY
APPROVED:
CHIEF ENGR

2



SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS — Professional Engineers & Planners
Mason City, Ia. – Rochester, Minn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: J. A. J.
DRAWN BY: D.L.E/K.R.R
CHECKED BY: J.D.S./D.O

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
BROADWAY ST. BRIDGE SCOUR PROTECTION

SUBMITTED BY:
CHIEF ED-D BRANCH
CHIEF ED-GH BRANCH

APPROVED:
CHIEF ENGR. DIVISION

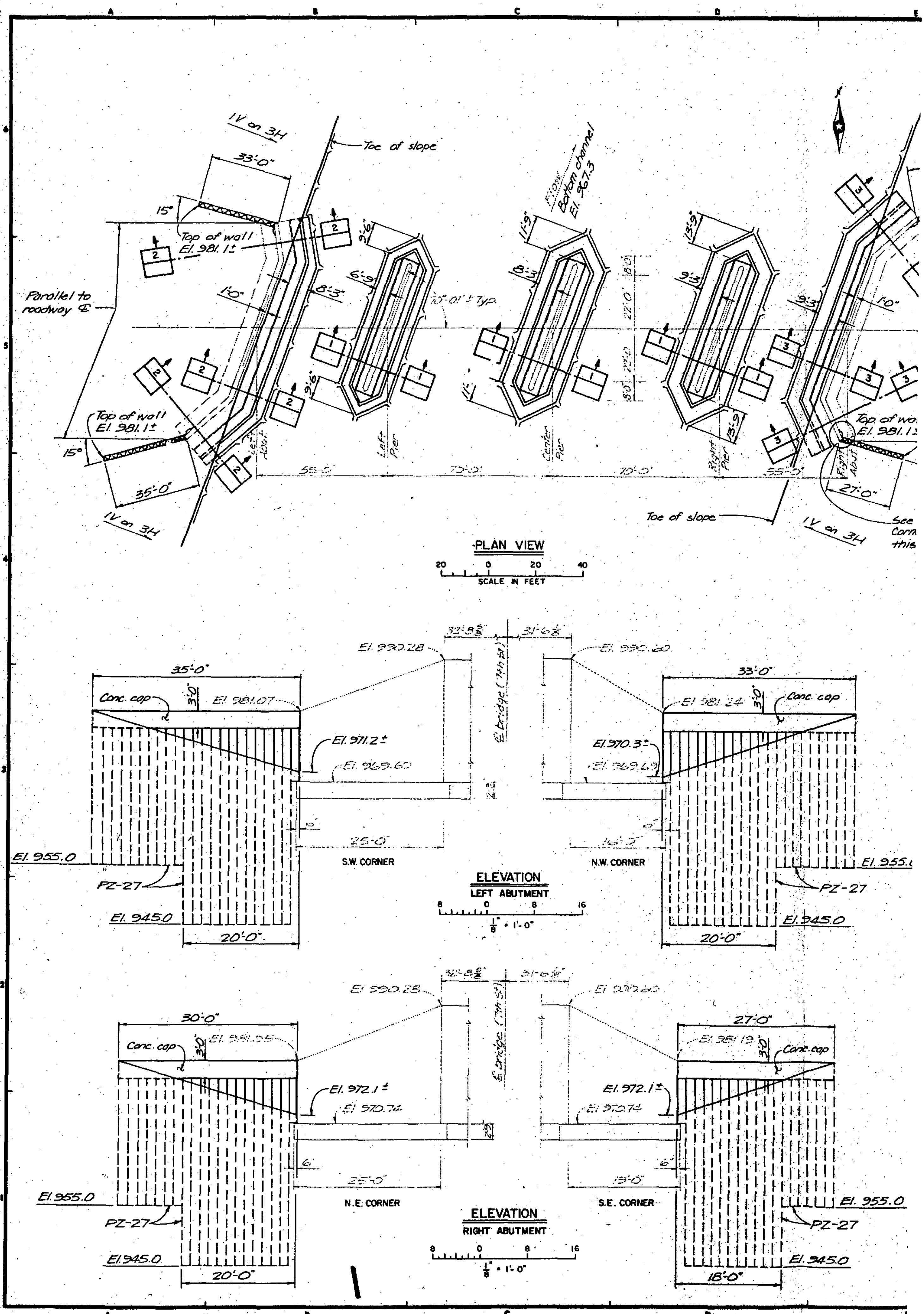
DATE: DECEMBER 1986

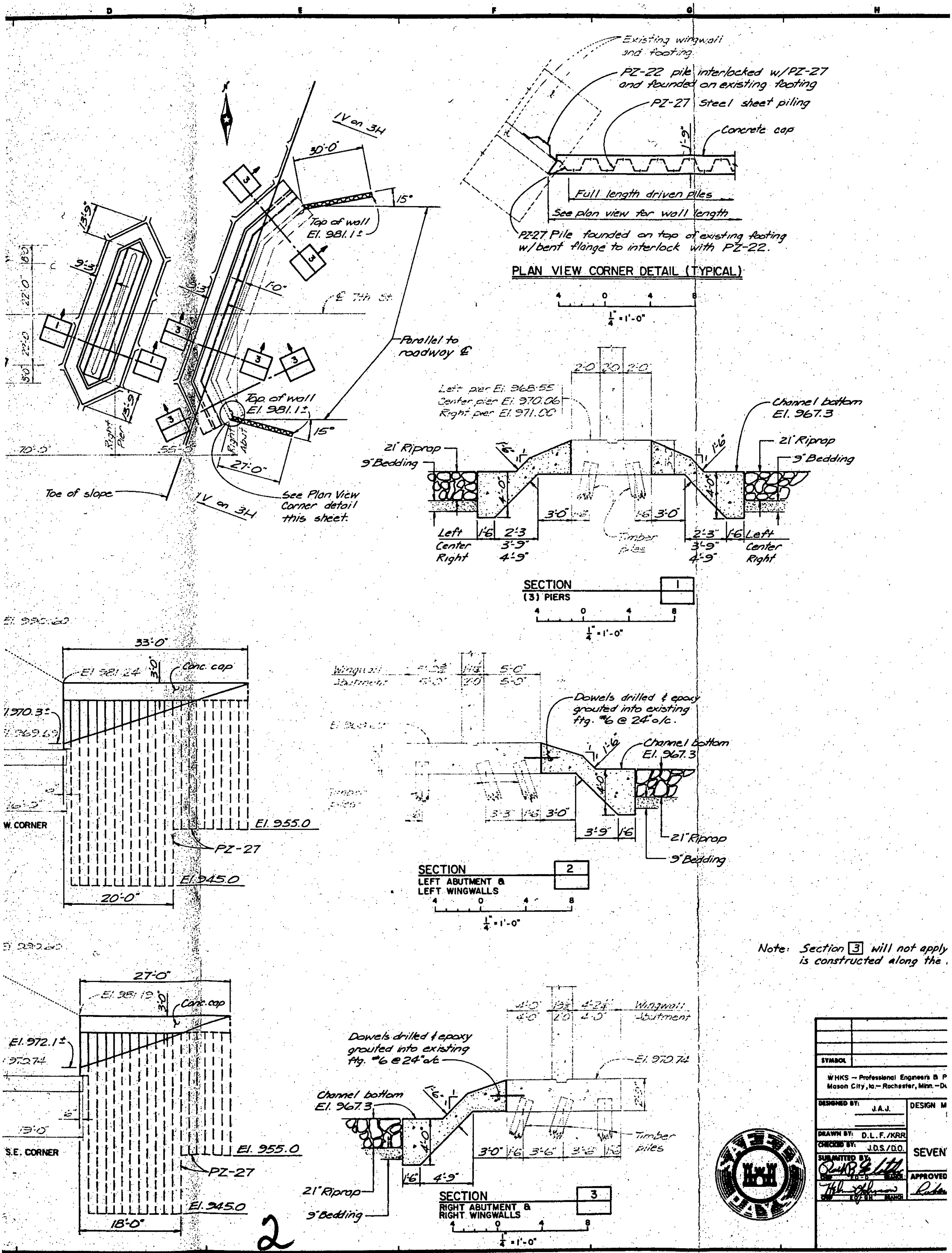
SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER
M30 - R - 61/1
SHEET 37 OF 45

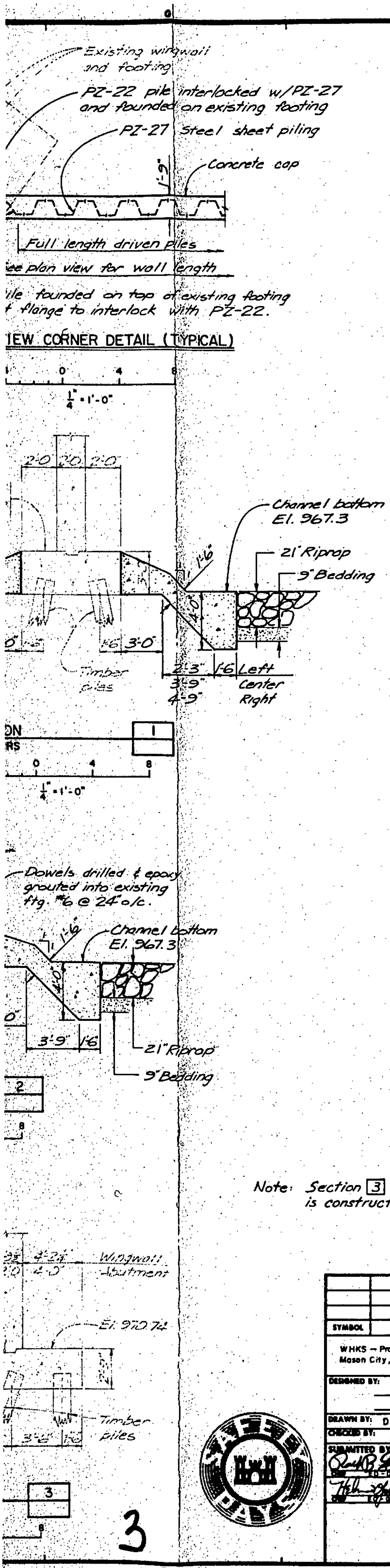
3

PLATE 37


1V on 3H
Toe of slope
33'-0"
15°
Top of wall
El. 981.1±
Parallel to
roadway ℄
1'-0"
8'-3"
9'-6"
6'-9"
70°-01'±Typ.
11'-9"
Flow
Bottom channel
El. 967.3
8'-3"
13'-9"
9'-3"
18'-0"
22'-0"
22'-0"
18'-0"
9'-3"
1'-0"
Top of wall
El. 981.1±
15°
35'-0"
1V on 3H
Left Abut.
Left Pier
Center Pier
Right Pier
Right Abut.
55'-0"
70'-0"
70'-0"
55'-0"
27'-0"
Toe of slope
1V on 3H
Top of wa.
El. 981.1±
PLAN VIEW
SCALE IN FEET
32'-8 5/8"
31'-6 3/8"
El. 990.28
El. 990.60
℄ bridge (74.5')
35'-0"
33'-0"
Conc. cap
3'-0"
El. 981.07
El. 981.24
Conc. cap
El. 971.2±
El. 969.60
El. 970.3±
El. 969.69
25'-0"
16'-2"
S.W. CORNER
N.W. CORNER
El. 955.0
El. 955.0
PZ-27
PZ-27
El. 945.0
El. 945.0
20'-0"
20'-0"
ELEVATION
LEFT ABUTMENT
1/8" = 1'-0"
32'-8 5/8"
31'-6 3/8"
El. 990.28
El. 990.60
℄ bridge (74.5')
30'-0"
27'-0"
Conc. cap
El. 981.05
El. 981.19
3'-0"
Conc. cap
El. 972.1±
El. 970.74
El. 972.1±
El. 970.74
25'-0"
13'-0"
N.E. CORNER
S.E. CORNER
El. 955.0
El. 955.0
PZ-27
PZ-27
El. 945.0
El. 945.0
20'-0"
18'-0"
ELEVATION
RIGHT ABUTMENT
1/8" = 1'-0"



Existing wingwall and footing
PZ-22 pile interlocked w/PZ-27 and founded on existing footing
PZ-27 Steel sheet piling
Concrete cap
1'-9"
Full length driven piles
See plan view for wall length
PZ-27 Pile founded on top of existing footing w/bent flange to interlock with PZ-22.
PLAN VIEW CORNER DETAIL (TYPICAL)
1/4" = 1'-0"
1V on 3H
30'-0"
15°
Top of wall El. 981.1±
1'-0"
℄ 7th St.
Parallel to roadway ℄
Top of wall El. 981.1±
15°
27'-0"
Right Pier
Right Abut.
Toe of slope
See Plan View Corner detail this sheet.
2'-0" 2'-0" 2'-0"
Left pier El. 968.55
Center pier El. 970.06
Right pier El. 971.00
Channel bottom El. 967.3
21" Riprap
9" Bedding
4'-0"
3'-0"
1'-6" 3'-0"
Timber piles
Left
Center
Right
1'-6"
2'-3"
3'-9"
4'-9"
SECTION 1
(3) PIERS
1/4" = 1'-0"
33'-0"
El. 981.24
3'-0"
Conc. cap
El. 955.0
W. CORNER
PZ-27
El. 945.0
20'-0"
Wingwall
Abutment
5'-0"
Dowels drilled & epoxy grouted into existing ftg. #6 @ 24" o/c.
Channel bottom El. 967.3
Timber piles
3'-3" 1'-6" 3'-0"
3'-9" 1'-6"
21" Riprap
9" Bedding
SECTION 2
LEFT ABUTMENT & LEFT WINGWALLS
1/4" = 1'-0"
Note: Section 3 will not apply is constructed along the
27'-0"
El. 981.19
3'-0"
Conc. cap
El. 972.1±
13'-0"
S.E. CORNER
El. 955.0
PZ-27
El. 945.0
18'-0"
4'-0" 4'-0"
Wingwall
Abutment
Dowels drilled & epoxy grouted into existing ftg. #6 @ 24" o/c
El. 970.74
Channel bottom El. 967.3
Timber piles
3'-0" 1'-6" 3'-6" 3'-6"
1'-6" 4'-9"
21" Riprap
9" Bedding
SECTION 3
RIGHT ABUTMENT & RIGHT WINGWALLS
1/4" = 1'-0"
SYMBOL
WHKS — Professional Engineers & P
Mason City, Ia.—Rochester, Minn.—D
DESIGNED BY: J.A.J.
DESIGN M
DRAWN BY: D.L.F./KRR
CHECKED BY: J.D.S./D.O.
SEVEN
SUBMITTED BY:
APPROVED
2



Note: Section $\boxed{3}$ will not apply if bike path underpass is constructed along the right abutment.

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Minn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

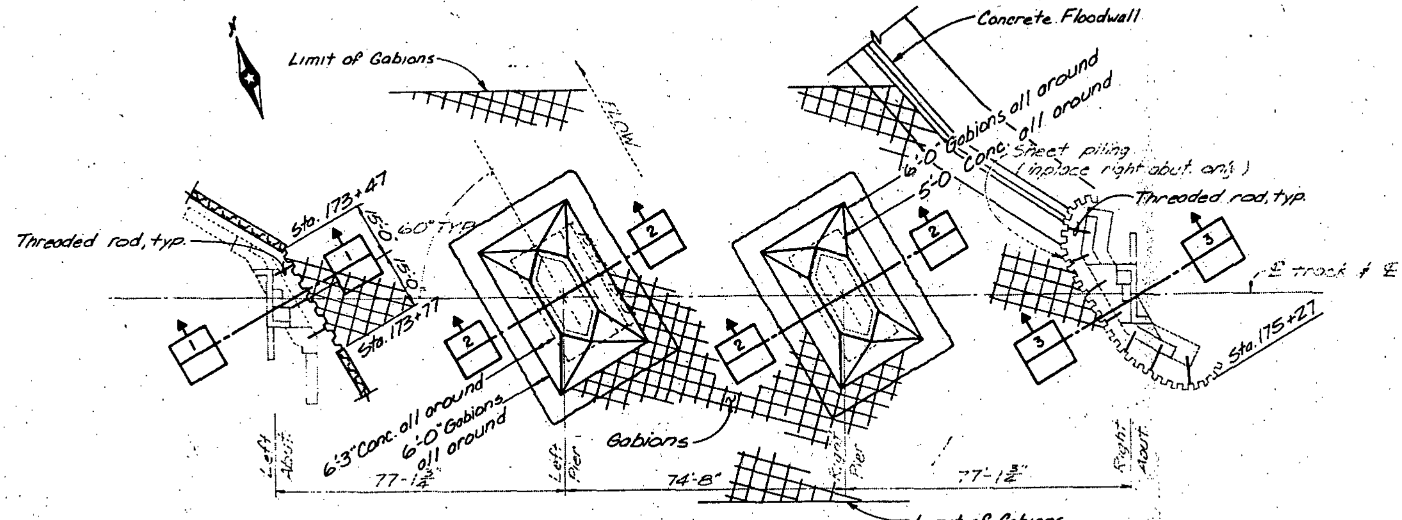
DESIGNED BY: J.A.J.
DRAWN BY: D.L.F./KRR
CHECKED BY: J.D.S./D.O.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
SEVENTH STREET BRIDGE SCOUR PROTECTION

APPROVED BY:
DATE: DECEMBER 1986
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER M30-R-61/2
SHEET 38 OF 45

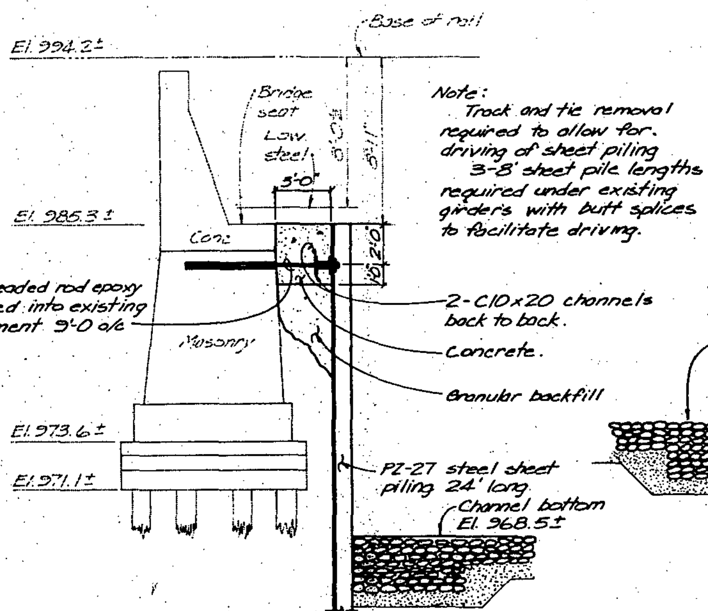
3

PLATE 38



PLAN VIEW

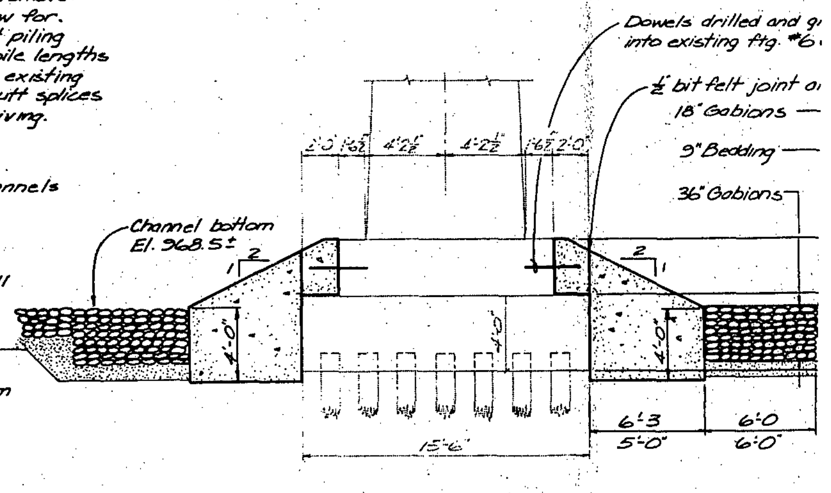
20 0 20 40
SCALE IN FEET



Note:
Track and tie removal required to allow for driving of sheet piling
3-8' sheet pile lengths required under existing girders with butt splices to facilitate driving.

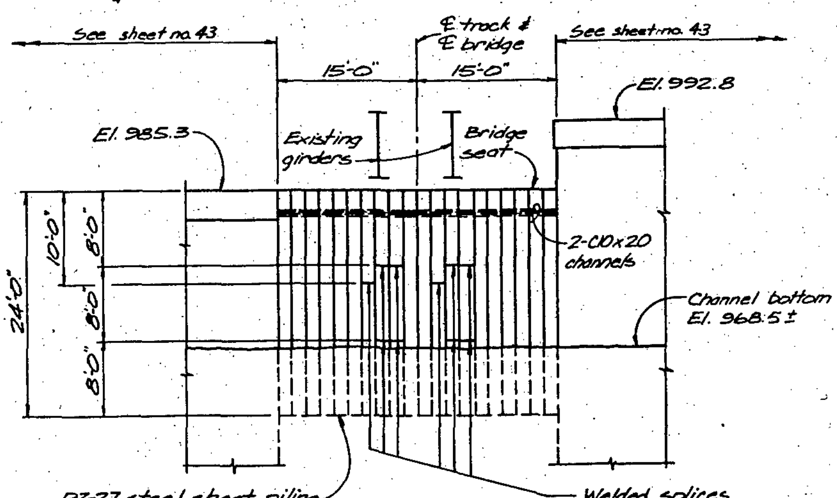
SECTION 1
LEFT ABUTMENT

4 0 4 8
¼" = 1'-0"



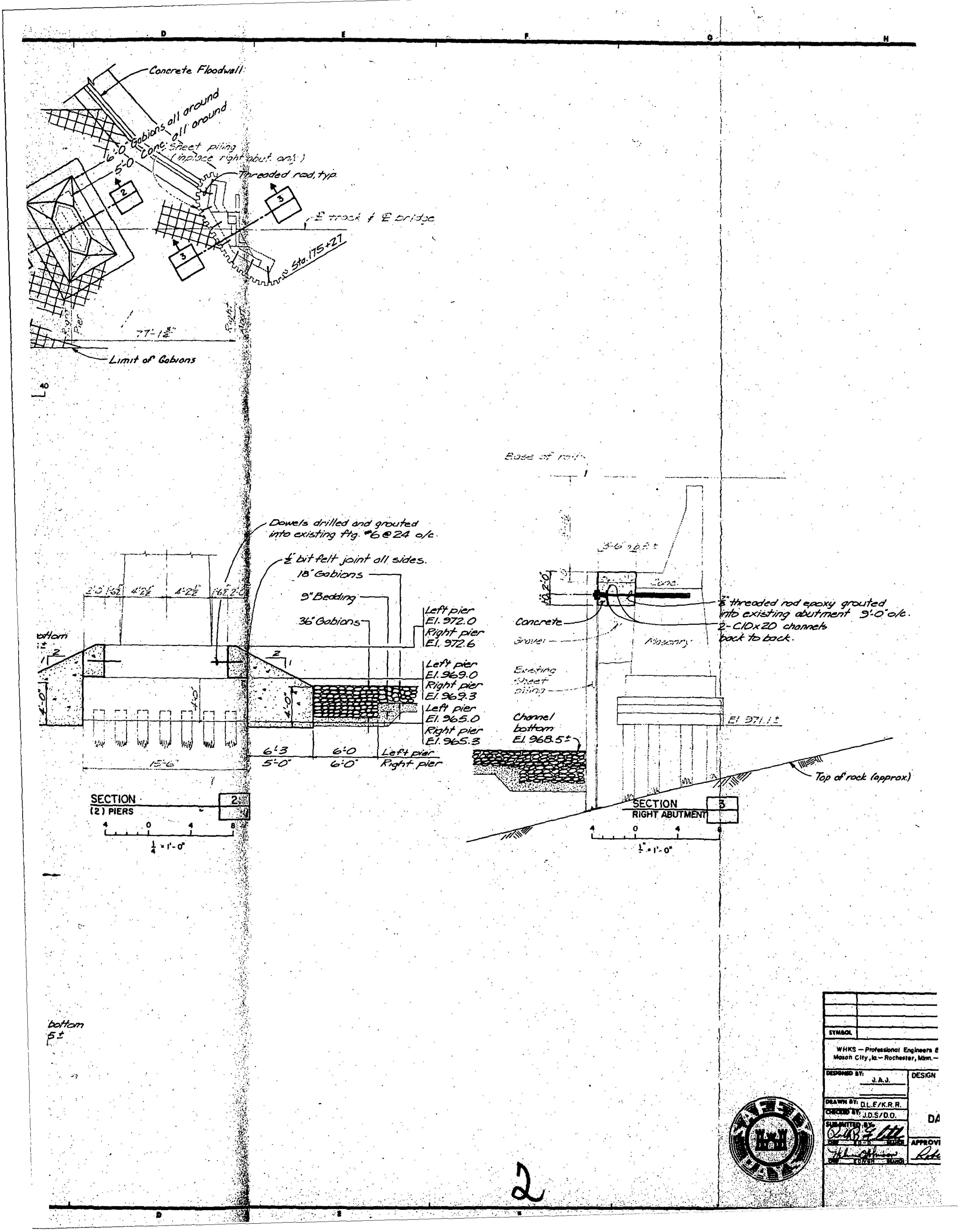
SECTION 2
(2) PIERS

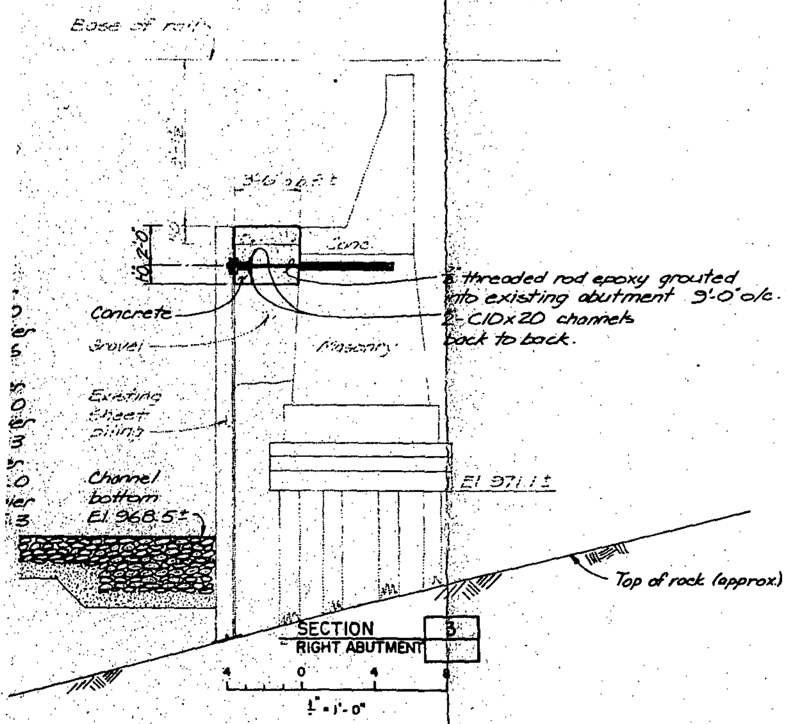
4 0 4 8
¼" = 1'-0"



ELEVATION
LEFT ABUTMENT

8 0 8 16
⅛" = 1'-0"


D
E
F
G
H
Concrete Floodwall
6'-0" Gobions all around
5'-0" Conc. all around
Sheet piling
(inplace right abut. only)
Threaded rod, typ.
2
3
3
℄ track & ℄ bridge
Sta. 175+27
Right Pier
Right Abut.
77'-1 3/4"
Limit of Gabions
Base of rail
Dowels drilled and grouted
into existing ftg. #6 @ 24 o/c.
1/2" bit felt joint all sides.
18" Gabions
9" Bedding
36" Gabions
Left pier
El. 972.0
Right pier
El. 972.6
Left pier
El. 969.0
Right pier
El. 969.3
Left pier
El. 965.0
Right pier
El. 965.3
2'-0"
4'-2 1/2"
4'-2 1/2"
2'-0"
4'-0"
4'-0"
4'-0"
15'-6"
6'-3"
6'-0"
Left pier
5'-0"
6'-0"
Right pier
bottom
SECTION 2
(2) PIERS
1/4" = 1'-0"
3'-6"
Conc.
Concrete
Gravel
Masonry
Existing
Sheet
piling
Channel
bottom
El. 968.5±
7/8" threaded rod epoxy grouted
into existing abutment 9'-0" o/c.
2-C10x20 channels
back to back.
El. 971.1±
Top of rock (approx.)
SECTION 3
RIGHT ABUTMENT
1/2" = 1'-0"
bottom
5±
SYMBOL
WHKS — Professional Engineers &
Mason City, Ia. — Rochester, Minn. —
DESIGNED BY: J.A.J.
DESIGN
DRAWN BY: D.L.E./K.R.R.
CHECKED BY: J.D.S./D.O.
SUBMITTED BY:
APPROV
DA
2



SECTION 3
RIGHT ABUTMENT

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS — Professional Engineers & Planners
Mason City, Ia. — Rochester, Minn. — Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: J.A.J.
DRAWN BY: D.L.E./K.R.R.
CHECKED BY: J.D.S./D.O.
SUBMITTED BY:

DESIGN MEMORANDUM NO.2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
DAKOTA, MINNESOTA & EASTERN RR.
BRIDGE SCOUR PROTECTION

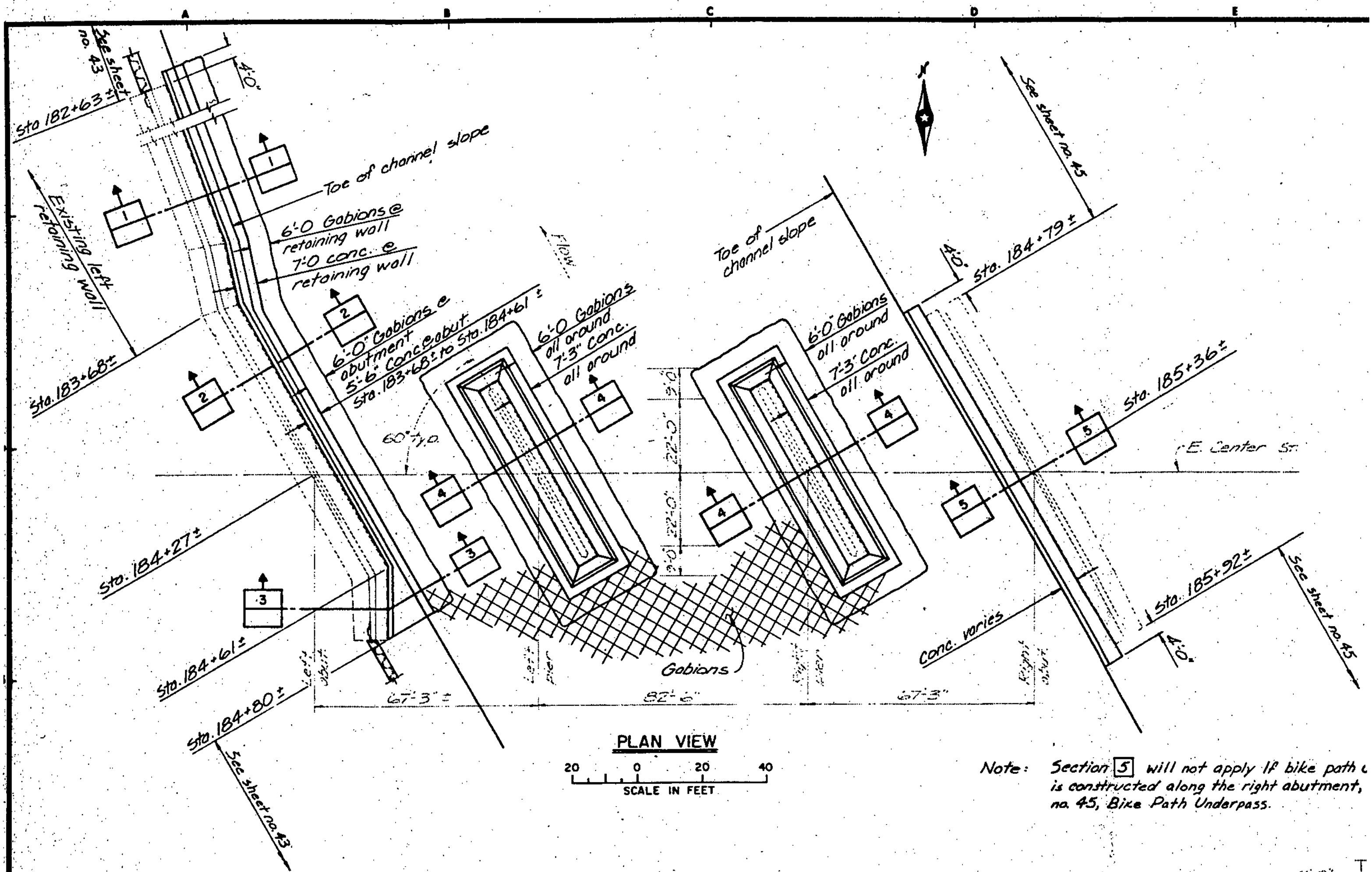
APPROVED BY:
CHIEF, ENGR. DIVISION

DATE: DECEMBER 1986

SCALE: AS SHOWN
SPEC. NO.:

DRAWING NUMBER
M30-R-61/3
SHEET 39 OF 46

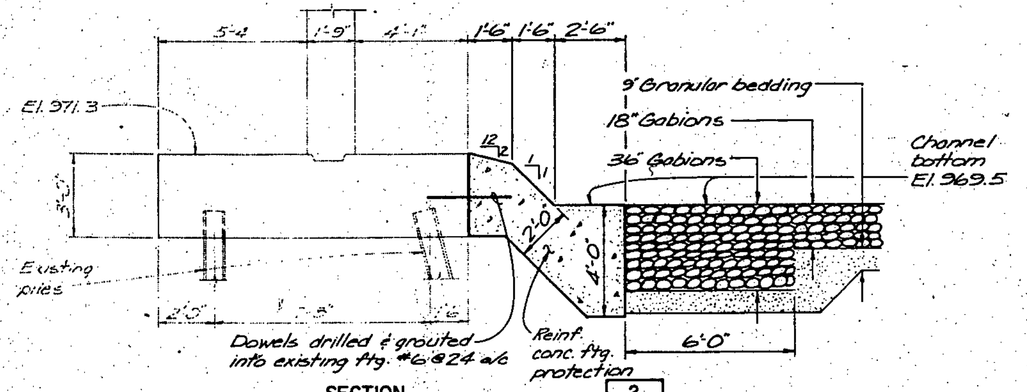
3



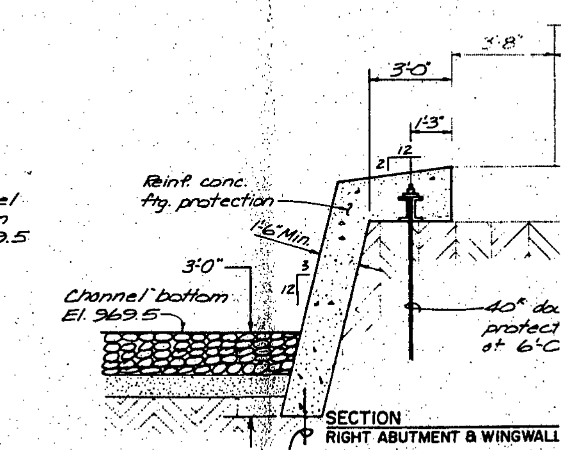
PLAN VIEW

SCALE IN FEET

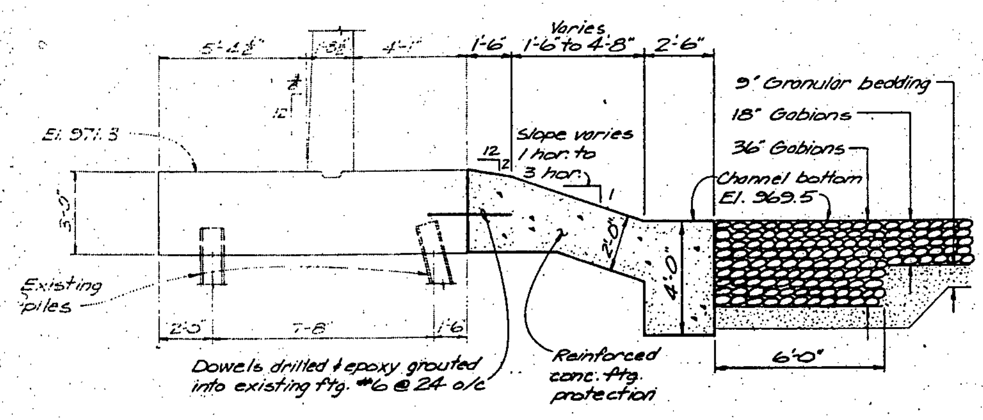
Note: Section [5] will not apply if bike path u... is constructed along the right abutment, ... no. 45, Bike Path Underpass.



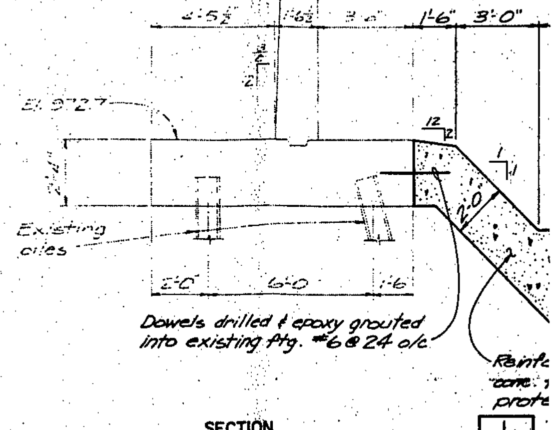
SECTION [2]
LEFT ABUTMENT
3/8" = 1'-0"



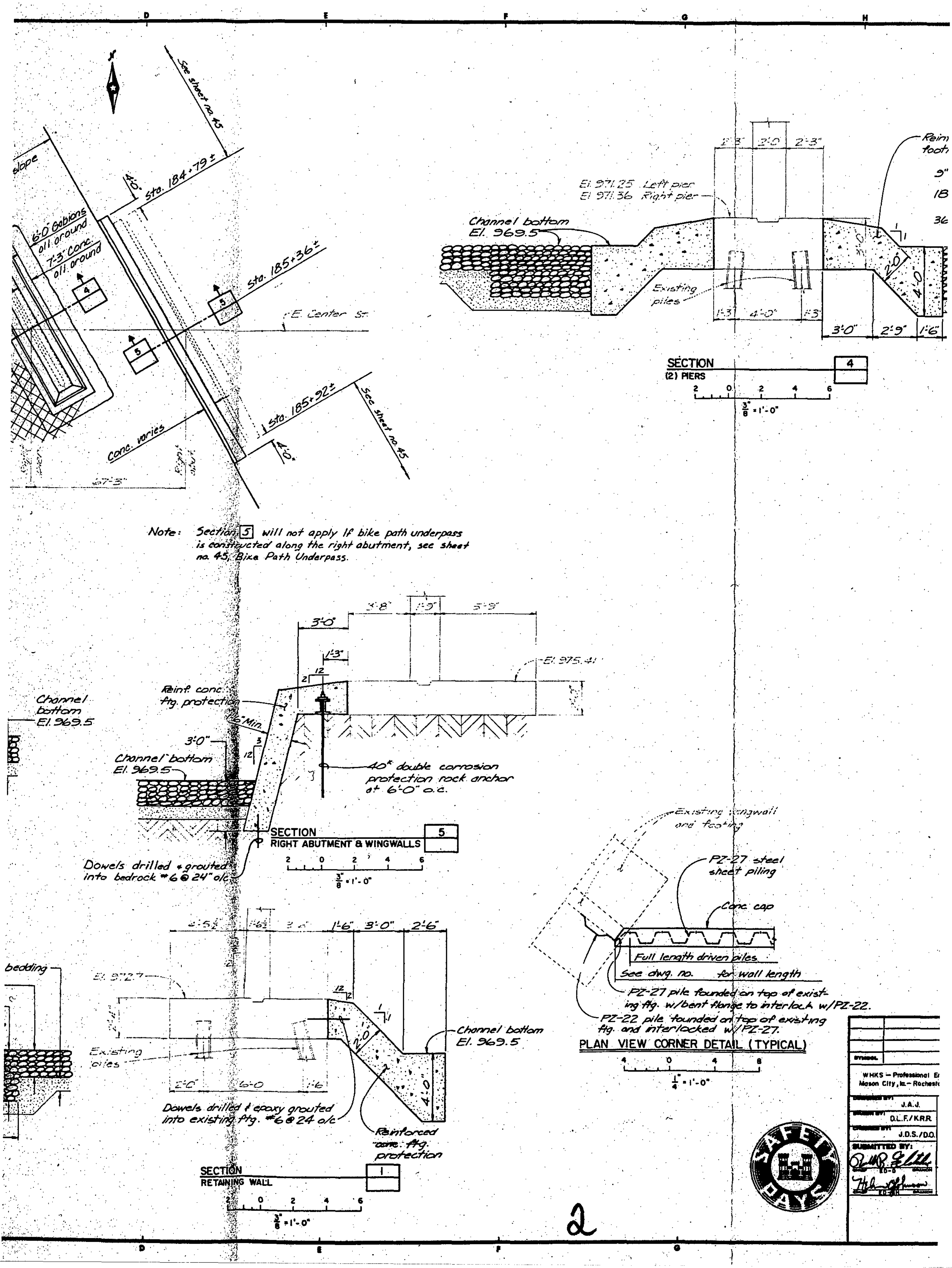
SECTION
RIGHT ABUTMENT & WINGWALL
3/8" = 1'-0"



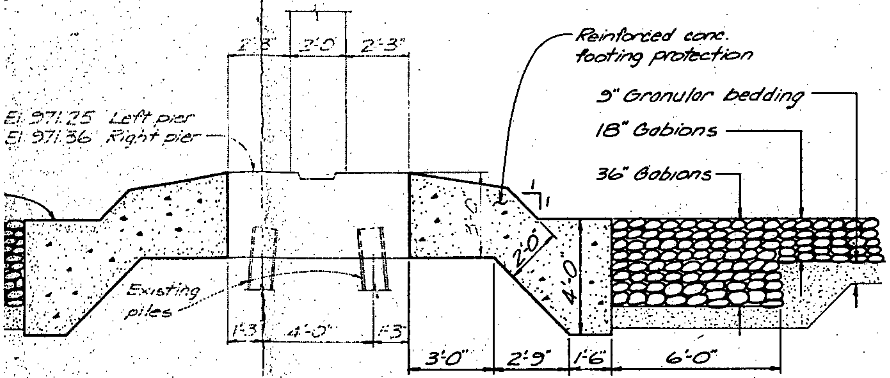
SECTION [3]
LEFT WINGWALL
STA. 184+61 ± to STA. 184+80 ±
3/8" = 1'-0"



SECTION [1]
RETAINING WALL
3/8" = 1'-0"

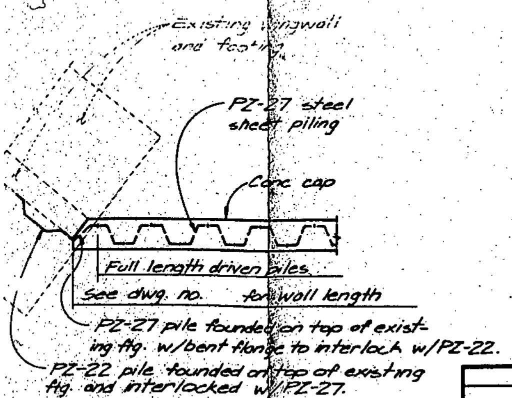


See sheet no. 45
Sta. 184+79 ±
4'-0"
slope
6'-0" Gabions all around
7'-3" Conc. all around
Sta. 185+36 ±
E. Center St.
Sta. 185+92 ±
Conc. varies
Right pier
Right abut.
67'-3"
4'-0"
See sheet no. 45
Note: Section 5 will not apply if bike path underpass is constructed along the right abutment, see sheet no. 45, Bike Path Underpass.
El. 971.25 Left pier
El. 971.36 Right pier
Channel bottom El. 969.5
Existing piles
2'-3" 2'-0" 2'-3"
1'-3" 4'-0" 1'-3"
3'-0" 2'-9" 1'-6"
2'-0" 4'-0"
Reinf. footi...
9"
18
36
SECTION 4
(2) PIERS
3/8" = 1'-0"
3'-8" 1'-9" 5'-9"
3'-0"
1'-3"
El. 975.41
Reinf. conc. ftg. protection
1'-6" Min.
Channel bottom El. 969.5
3'-0"
Channel bottom El. 969.5
40# double corrosion protection rock anchor at 6'-0" o.c.
SECTION 5
RIGHT ABUTMENT & WINGWALLS
3/8" = 1'-0"
Dowels drilled + grouted into bedrock #6 @ 24" o/c
Existing wingwall and footing
PZ-27 steel sheet piling
Conc. cap
Full length driven piles
See dwg. no. for wall length
PZ-27 pile founded on top of existing ftg. w/bent flange to interlock w/PZ-22.
PZ-22 pile founded on top of existing ftg. and interlocked w/PZ-27.
PLAN VIEW CORNER DETAIL (TYPICAL)
1/4" = 1'-0"
bedding
4'-5½" 1'-6½" 3'-4" 1'-6" 3'-0" 2'-6"
El. 972.7
Existing piles
2'-0" 6'-0" 1'-6"
Channel bottom El. 969.5
2'-0" 4'-0"
Dowels drilled & epoxy grouted into existing ftg. #6 @ 24 o/c
Reinforced conc. ftg. protection
SECTION 1
RETAINING WALL
3/8" = 1'-0"
2
WHKS — Professional E...
Mason City, Ia. — Rochest...
J.A.J.
D.L.F./K.R.R.
J.D.S./D.O.
SUBMITTED BY:
SAFETY PAYS



SECTION 4
(2) PIERS

$\frac{3}{8}" = 1'-0"$



PLAN VIEW CORNER DETAIL (TYPICAL)

$\frac{1}{4}" = 1'-0"$

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Minn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

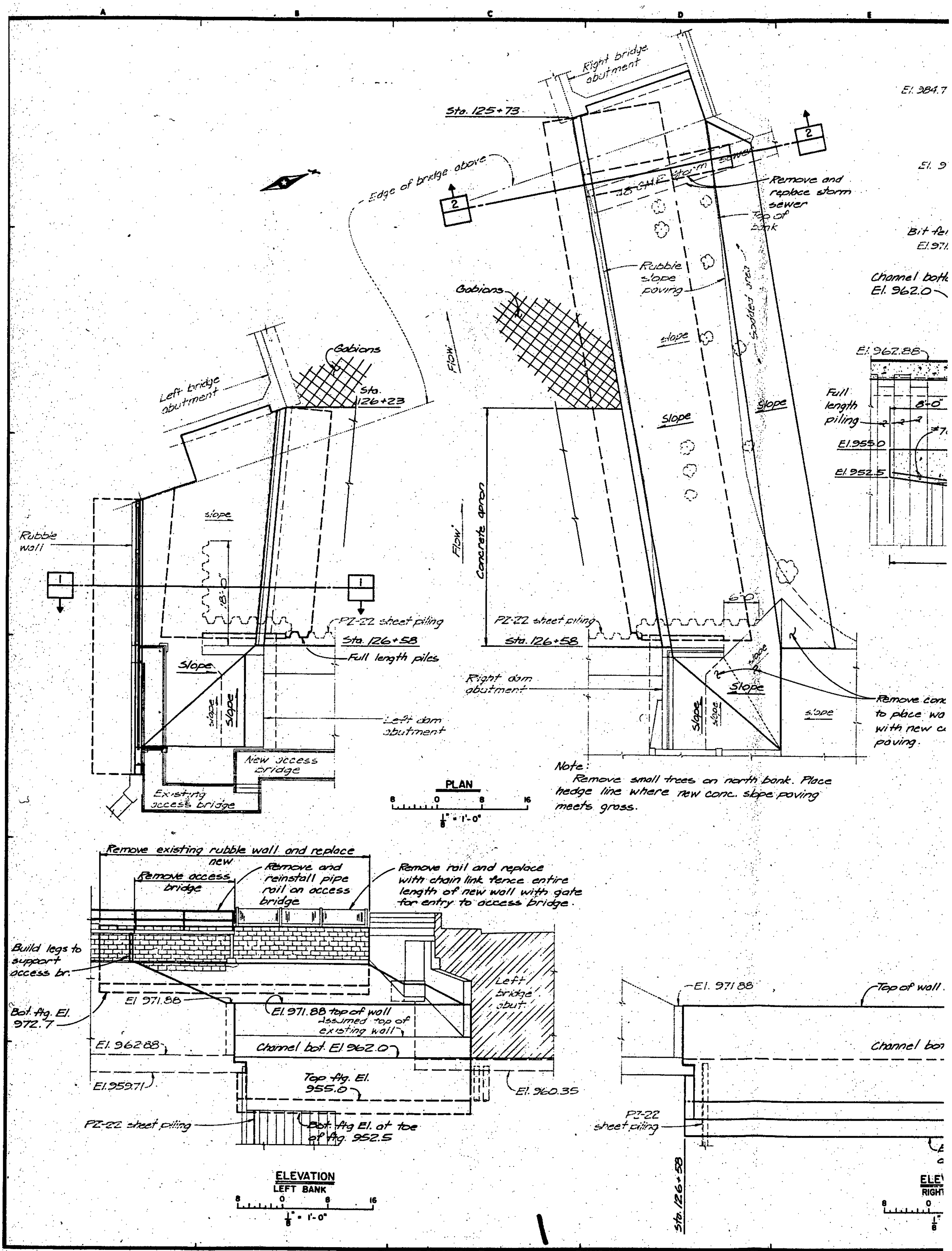
DESIGNED BY: J.A.J.
DRAWN BY: D.L.F./K.R.R.
CHECKED BY: J.D.S./D.O.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 — FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
CENTER STREET BRIDGE SCOUR PROTECTION

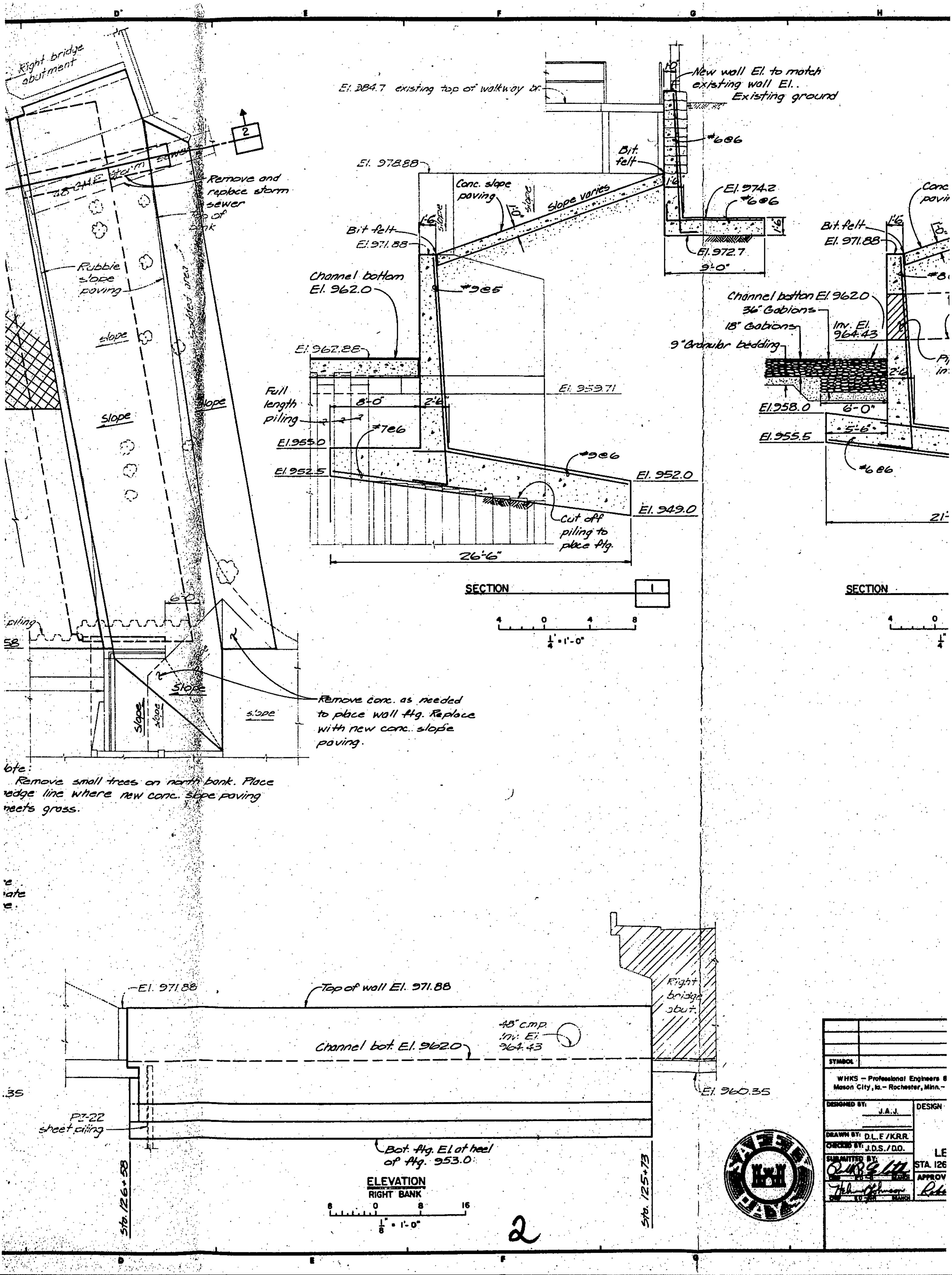
APPROVED:
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER M30-R-61/4
SHEET 40 OF 45

3

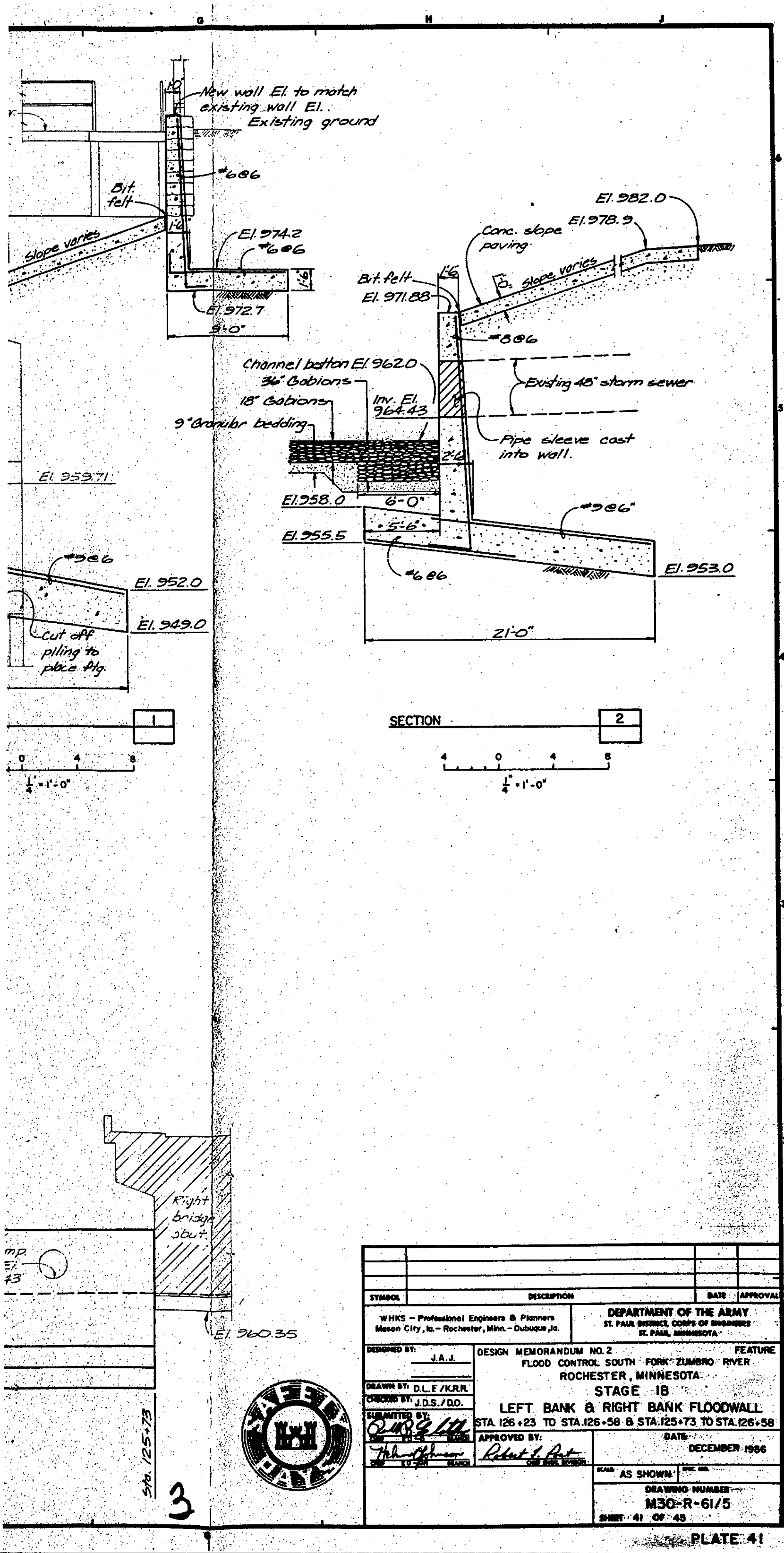
PLATE 40

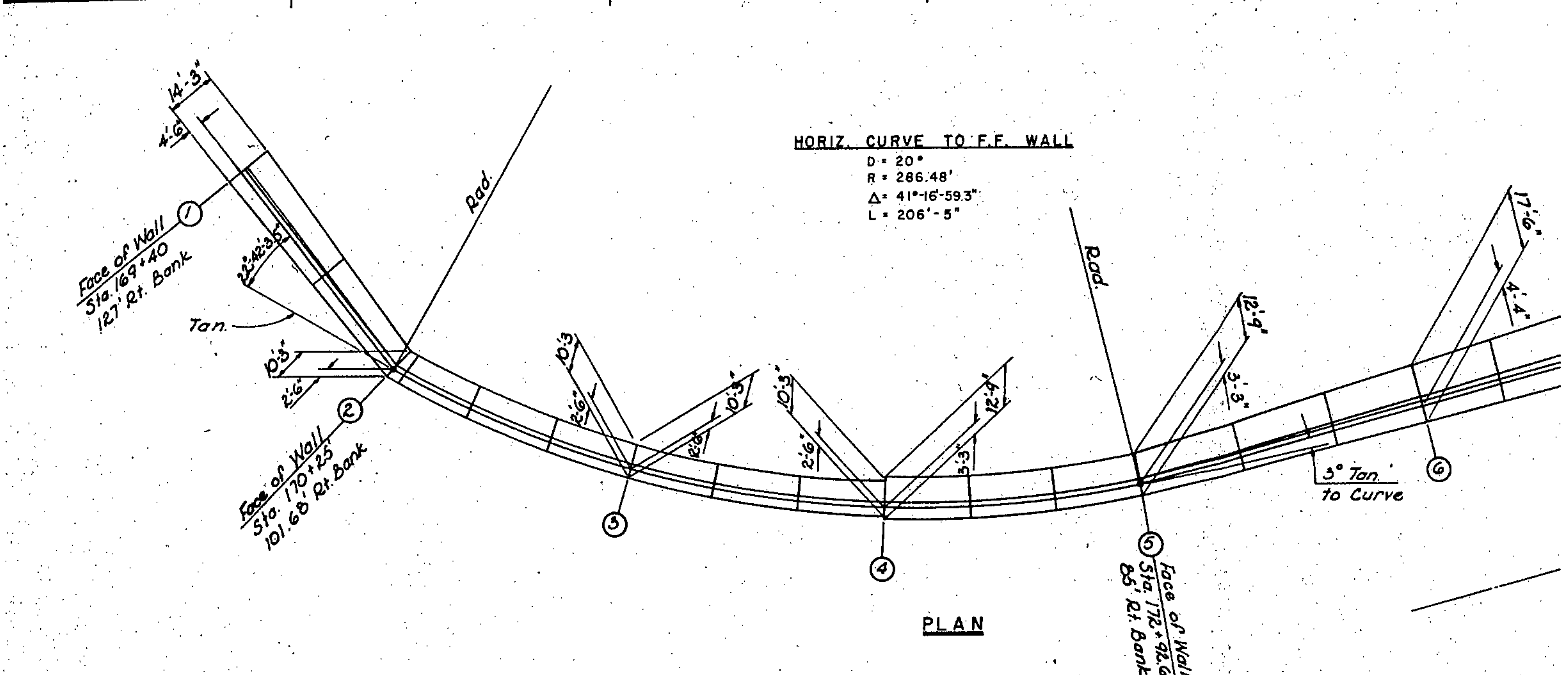


Right bridge abutment
Sta. 125+73
Edge of bridge above
Remove and replace storm sewer
Top of bank
Rubble slope paving
Gabions
Sodded area
slope
Flow
Left bridge abutment
Sta. 126+23
Concrete apron
Rubble wall
18'-0"
6'-0"
PZ-22 sheet piling
Sta. 126+58
Full length piles
Right dam abutment
Left dam abutment
New access bridge
Existing access bridge
Slope
Remove conc. to place wa with new c paving.
Note:
Remove small trees on north bank. Place hedge line where new conc. slope paving meets grass.
PLAN
8 0 8 16
1/8" = 1'-0"
El. 984.7
Bit fe El. 971.
Channel bott El. 962.0
El. 962.88
Full length piling
8'-0"
El. 955.0
El. 952.5
Remove existing rubble wall and replace new
Remove access bridge
Remove and reinstall pipe rail on access bridge
Remove rail and replace with chain link fence entire length of new wall with gate for entry to access bridge.
Build legs to support access br.
Bot. ftg. El. 972.7
El 971.88
El. 971.88 top of wall
Assumed top of existing wall
El. 962.88
Channel bot. El. 962.0
El. 959.71
Top ftg. El. 955.0
El. 960.35
Left bridge abut.
PZ-22 sheet piling
Bot. ftg El. at toe of ftg. 952.5
ELEVATION
LEFT BANK
8 0 8 16
1/8" = 1'-0"
El. 971.88
Top of wall.
Channel bo
PZ-22 sheet piling
Sta. 126+58
ELE
RIGHT
A B C D E

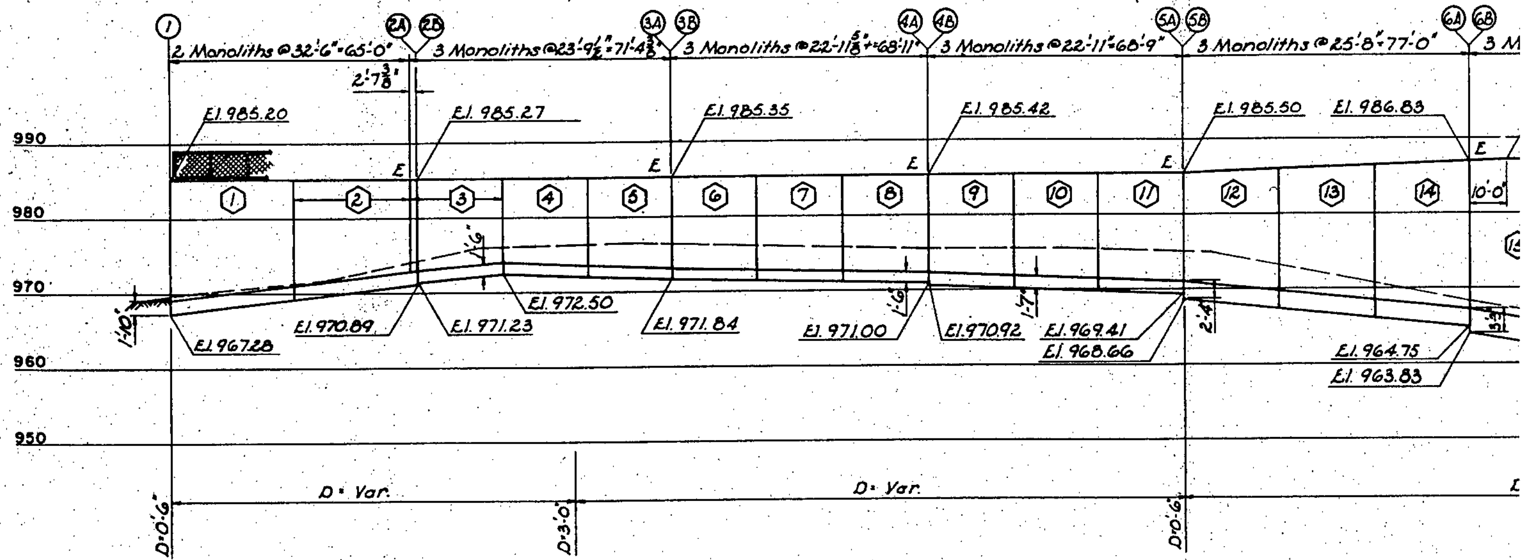


D
E
F
G
H
Right bridge abutment
2
48" CMP storm sewer
Remove and replace storm sewer
Top of bank
Rubble slope paving
slope
Slope
Slope
sodded area
piling
58
6'-0"
Slope
slope
slope
slope
Remove conc. as needed to place wall ftg. Replace with new conc. slope paving.
ote:
Remove small trees on north bank. Place edge line where new conc. slope paving meets grass.
El. 984.7 existing top of walkway br.
New wall El. to match existing wall El..
Existing ground
1'-0"
#6@6
Bit. felt
El. 978.88
Conc. slope paving
Slope varies
1'-6
2:1 slope
1'-6
El. 974.2
#6@6
1'-6
Bit felt
El. 971.88
El. 972.7
9'-0"
Channel bottom El. 962.0
#9@5
El. 962.88
El. 959.71
Full length piling
8'-0"
2'-6"
#7@6
El. 955.0
#9@6
El. 952.5
El. 952.0
El. 949.0
Cut off piling to place ftg.
26'-6"
SECTION 1
4 0 4 8
1/4" = 1'-0"
Conc. pavi
Bit. felt
El. 971.88
Channel botton El. 962.0
36" Gabions
18" Gabions
Inv. El. 964.43
9" Granular bedding
2'-6
El. 958.0
6'-0"
5'-6"
El. 955.5
#6@6
21'
SECTION
4 0
1/4"
El. 971.88
Top of wall El. 971.88
48" c.m.p. Inv. El. 964.43
Channel bot. El. 962.0
Right bridge abut.
El. 960.35
.35
PZ-22 sheet piling
Bot. ftg. El. at heel of ftg. 953.0
Sta. 126+58
Sta. 125+73
ELEVATION
RIGHT BANK
8 0 8 16
1/8" = 1'-0"
2
SYMBOL
WHKS – Professional Engineers & Mason City, Ia. – Rochester, Minn.
DESIGNED BY: J.A.J.
DESIGN
DRAWN BY: D.L.F./K.R.R.
CHECKED BY: J.D.S./D.O.
SUBMITTED BY:
STA. 126
APPROV
LE


New wall El. to match existing wall El.
Existing ground
#6@6
Bit. felt
slope varies
El. 974.2
#6@6
El. 972.7
3'-0"
El. 959.71
#9@6
El. 952.0
El. 949.0
Cut off piling to place ftg.
1
1/4" = 1'-0"
El. 982.0
El. 978.9
Conc. slope paving
slope varies
Bit. felt
El. 971.88
#8@6
Channel bottom El. 962.0
36" Gabions
18" Gabions
9" Granular bedding
Inv. El. 964.43
Existing 48" storm sewer
Pipe sleeve cast into wall.
El. 958.0
6'-0"
5'-6"
2'-6"
#9@6"
El. 955.5
#6@6
El. 953.0
21'-0"
SECTION 2
1/4" = 1'-0"
Right bridge abut.
El. 960.35
Sta. 125+73
3
SYMBOL
DESCRIPTION
DATE
APPROVAL
WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Minn. – Dubuque, Ia.
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
DESIGNED BY: J.A.J.
DRAWN BY: D.L.F./K.R.R.
CHECKED BY: J.D.S./D.O.
SUBMITTED BY:
DESIGN MEMORANDUM NO. 2
FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
LEFT BANK & RIGHT BANK FLOODWALL
STA. 126+23 TO STA. 126+58 & STA. 125+73 TO STA. 126+58
APPROVED BY:
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER
M30-R-61/5
SHEET 41 OF 48



PLAN

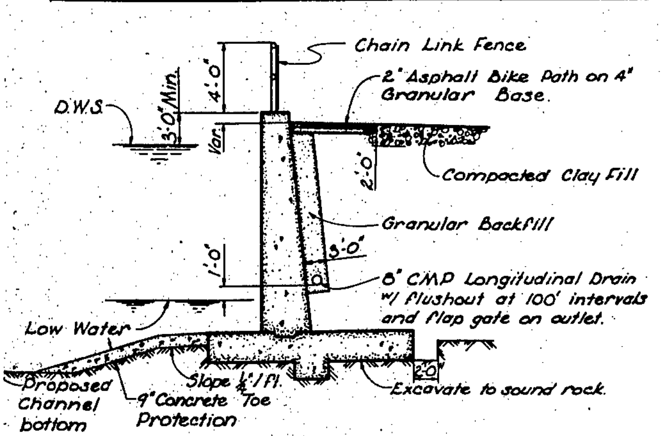


ELEVATION

HORIZONTAL DIMENSIONS ALONG FRONT FACE OF WALL

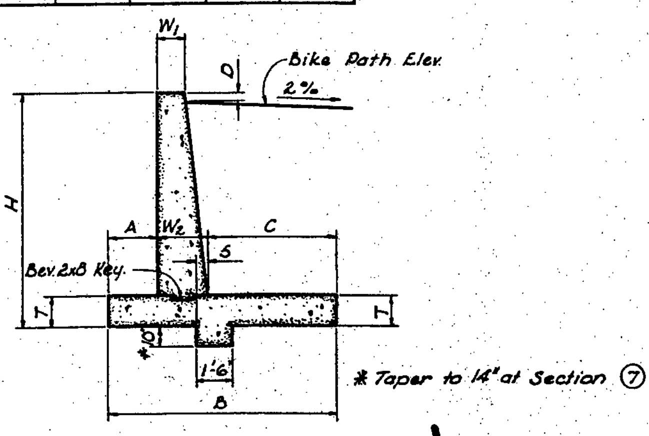
FLOOD WALL DIMENSION TABLE

	1	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B	7	8
A	4'-6"	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	3'-3"	3'-3"	3'-3"	4'-4"	4'-4"	5'-6"	5'-0"
B	14'-3"	10'-3"	10'-3"	10'-3"	10'-3"	10'-3"	12'-9"	12'-9"	12'-9"	17'-6"	17'-6"	22'-6"	19'-3"
C	7'-11"	6'-3	6'-3"	6'-3"	6'-3"	6'-3"	8'-0"	7'-11"	7'-11"	10'-10"	10'-10"	13'-5"	11'-0"
H	17'-11"	14'-4½"	14'-0½"	13'-6"	13'-6"	14'-5"	14'-6"	16'-1"	16'-10"	22'-1"	23'-0"	28'-0½"	24'-8"
T	1'-10"	1'-10"	1'-6"	1'-6"	1'-6"	1'-6"	1'-7"	1'-7"	2'-4"	2'-4"	3'-3"	3'-3"	3'-3"
W_1	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"
W_2	1'-10"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-7"	1'-7"	2'-4"	2'-4"	3'-7"	3'-3"



BACKFILL DETAIL

NO SCALE

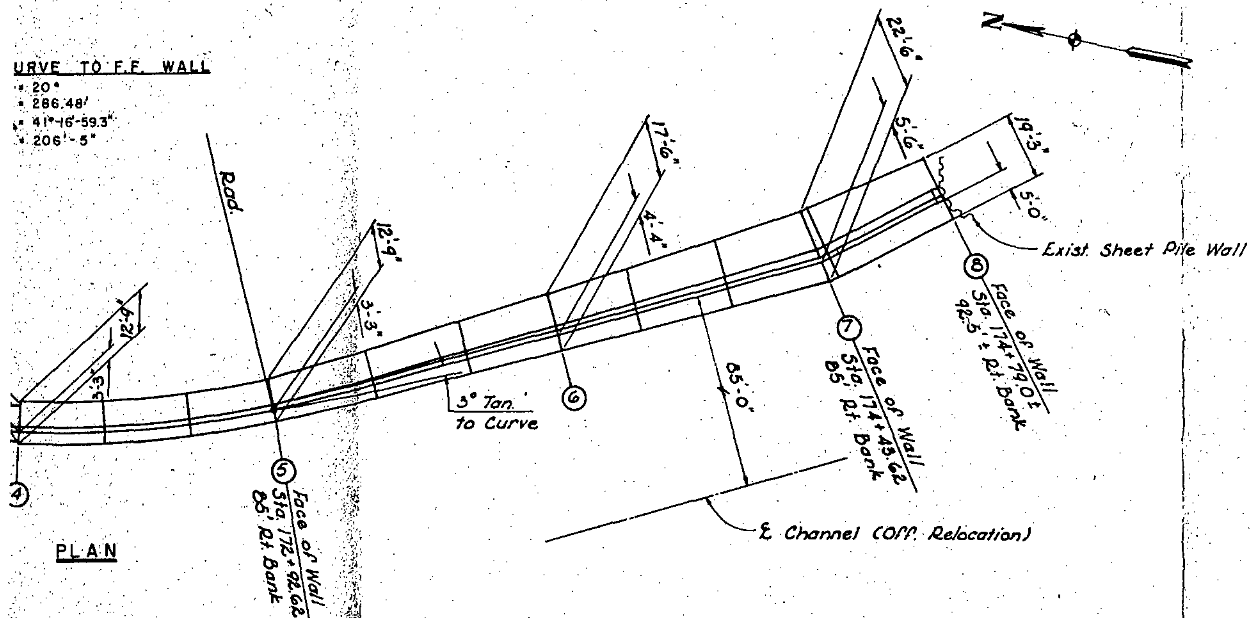


* Taper to 14" at Section 7

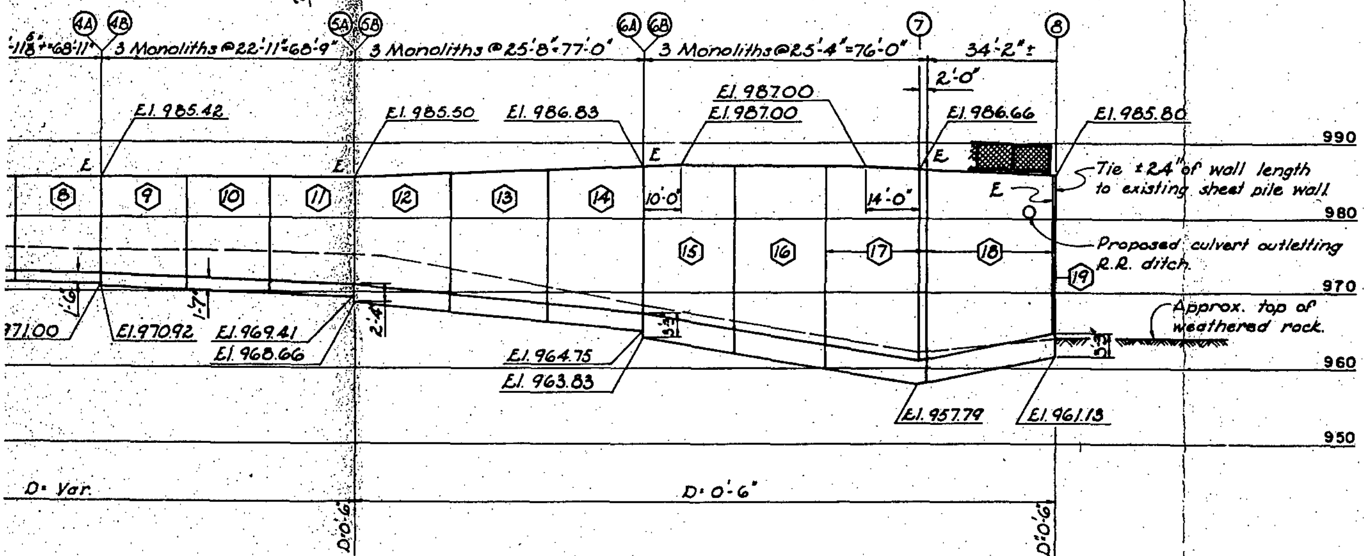
TYPICAL SECTION

NO SCALE

URVE TO F.F. WALL
= 20°
= 286.48'
= 41°-16'-59.3"
= 206'-5"

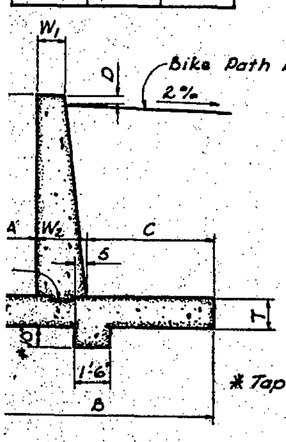


PLAN



ELEVATION
ENSIONS ALONG FRONT FACE OF WALL

6B	7	8
4'-4"	5'-6"	5'-0"
17'-6"	22'-6"	19'-3"
10'-10"	18'-5"	11'-0"
23'-0"	28'-10½"	24'-8"
3'-3"	3'-3"	3'-3"
1'-6"	1'-6"	1'-6"
2'-4"	3'-7"	3'-3"

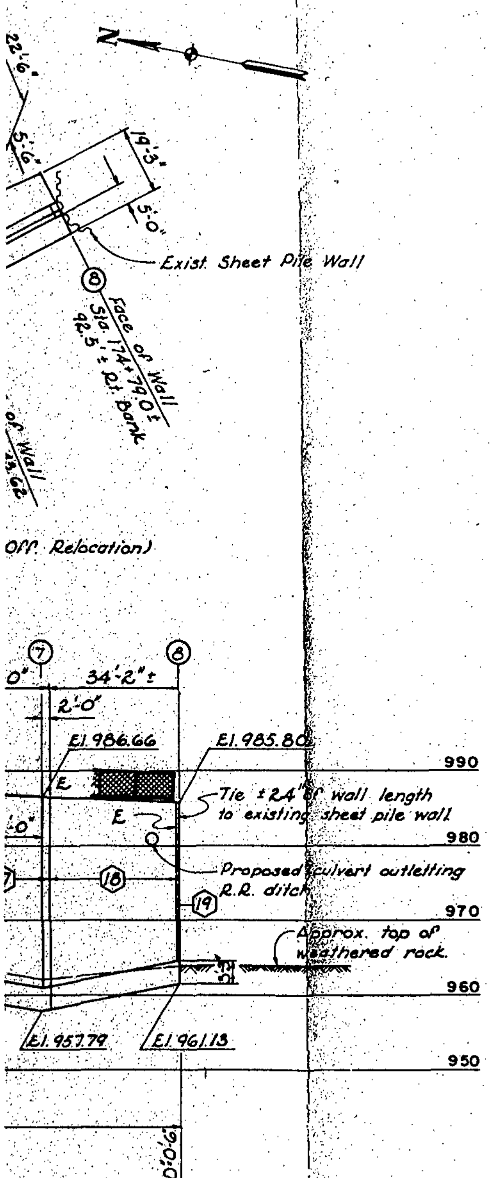


* Taper to 14" at Section 7

PICAL SECTION
NO SCALE

2

SYMBOL
WHKS - Professional Engineers
Mason City, Ia. - Rochester, Mi
DESIGNED BY: C.E.W.
DRAWN BY: L.M.G.
CHECKED BY: G.E.G.
SUBMITTED BY:



SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Mn. – Dubuque, Ia.

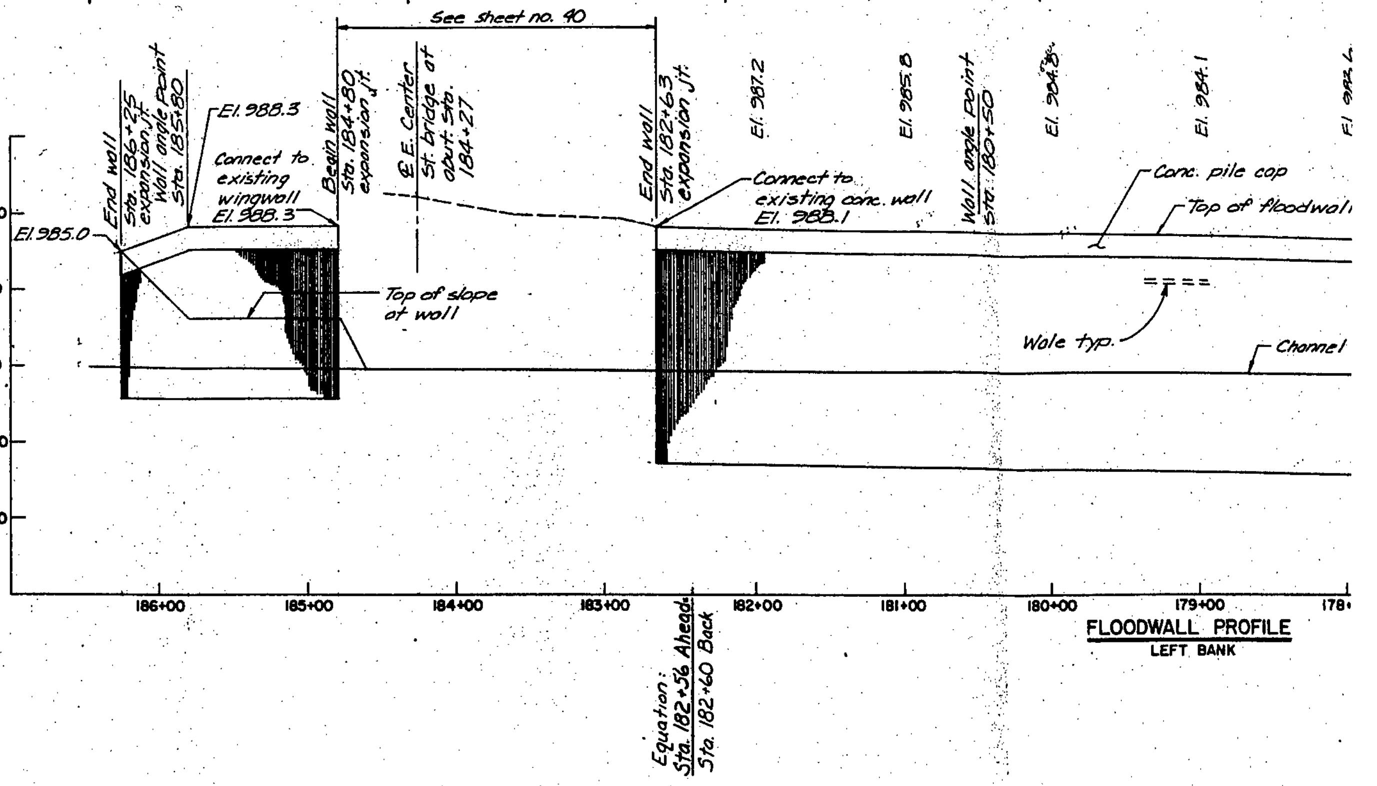
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: C.E.W.
DRAWN BY: L.M.G.
CHECKED BY: G.E.G.
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
RIGHT BANK FLOODWALL
STA. 169+40 TO STA. 174+79

APPROVED BY:
DATE: DECEMBER 1986
SCALE: 1" = 20' HOR. 1" = 10' VERT.
DRAWING NUMBER: M30-R-61/6
SHEET 42 OF 45

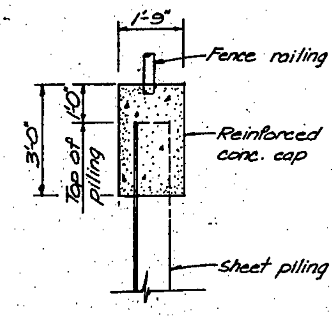
3



FLOODWALL PROFILE

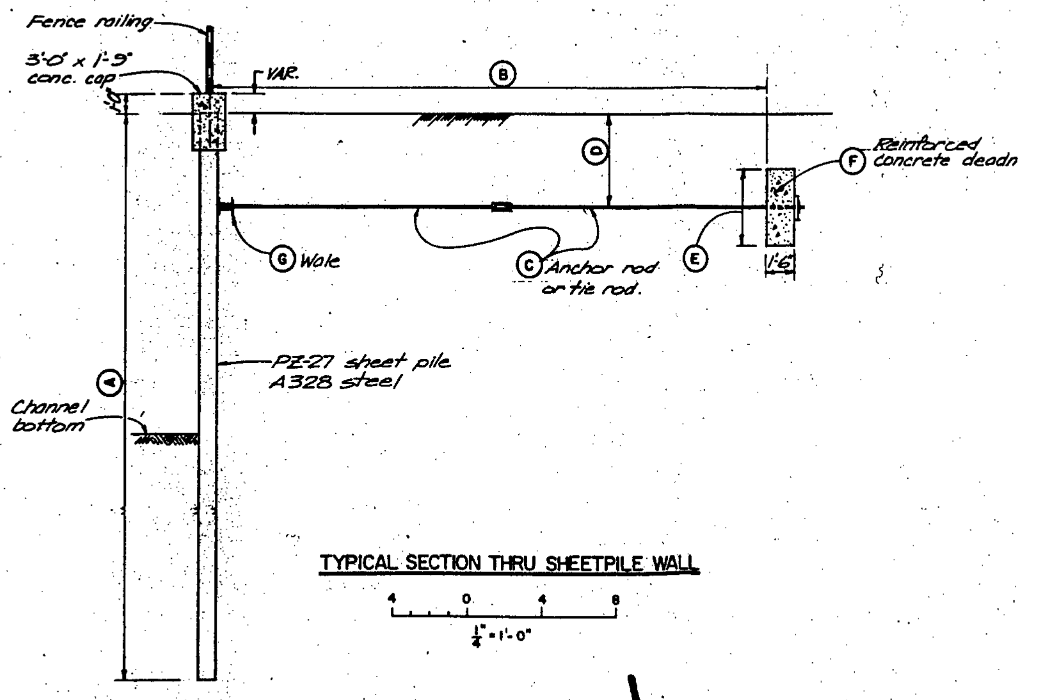
LEFT BANK

Station		172+40 to 173+47	173+77 to 182+63	184+80 to 186+25
Length of sheet pile	A	41'-0"	30'-0"	22'-6"
Distance to deadman	B	42'-0"	30'-0"	21'-0"
Anchor type	C	2¾"Ø upset to 3¼"Ø	2"Ø upset to 2½"Ø	2"Ø upset to 2½"Ø
Depth to soil anchor	D	5'-0"	6'-0"	4'-0"
Depth of deadman	E	8'-0"	4'-0"	4'-0"
Type of deadman	F	Continuous	Continuous	Continuous
Top wale steel	G	2-C15 x 33.9	2-C10 x 20	2-C10 x 20
Anchor spacing		9'-0"	9'-0"	12'-0"



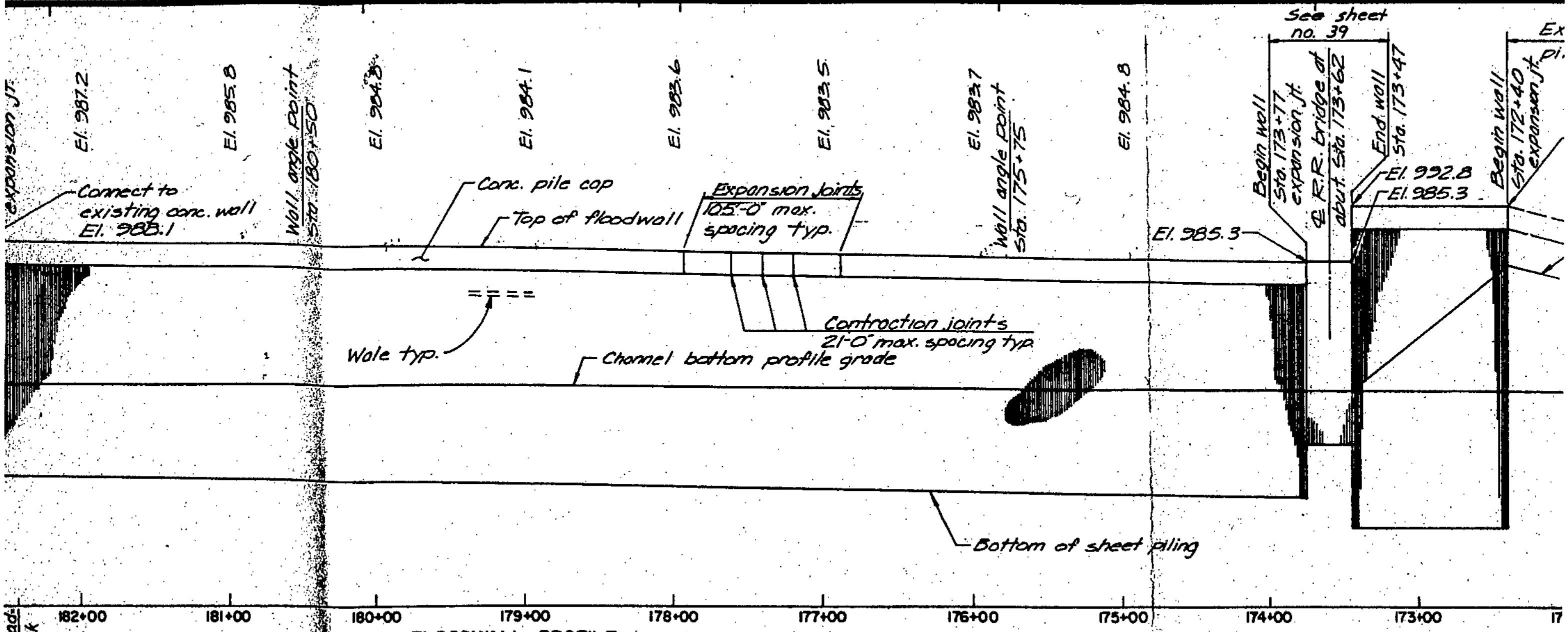
PILE CAP DETAIL

½" = 1'-0"



TYPICAL SECTION THRU SHEETPILE WALL

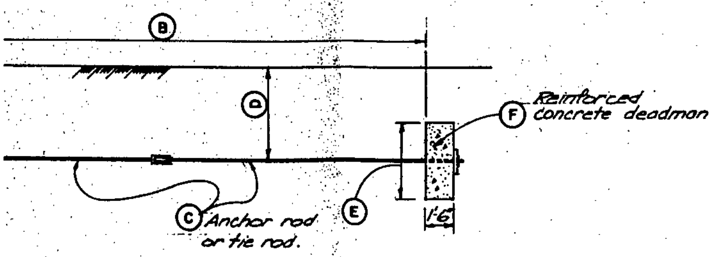
¼" = 1'-0"



FLOODWALL PROFILE
LEFT BANK

	173+77 to 182+63	184+80 to 186+25
	30'-0"	22'-6"
	30'-0"	21'-0"
⌀	2" ⌀ upset to $2\frac{1}{2}$" ⌀	2" ⌀ upset to $2\frac{1}{2}$" ⌀
	6'-0"	4'-0"
	4'-0"	4'-0"
	Continuous	Continuous
	2-C10 x 20	2-C10 x 20
	9'-0"	12'-0"

Notes:
Anchors to be upset to larger diameter at the anchor threads.
All anchors to be double corrosion protected, A36 steel.
Block building at Sta 177+50 120' LT. to be removed.



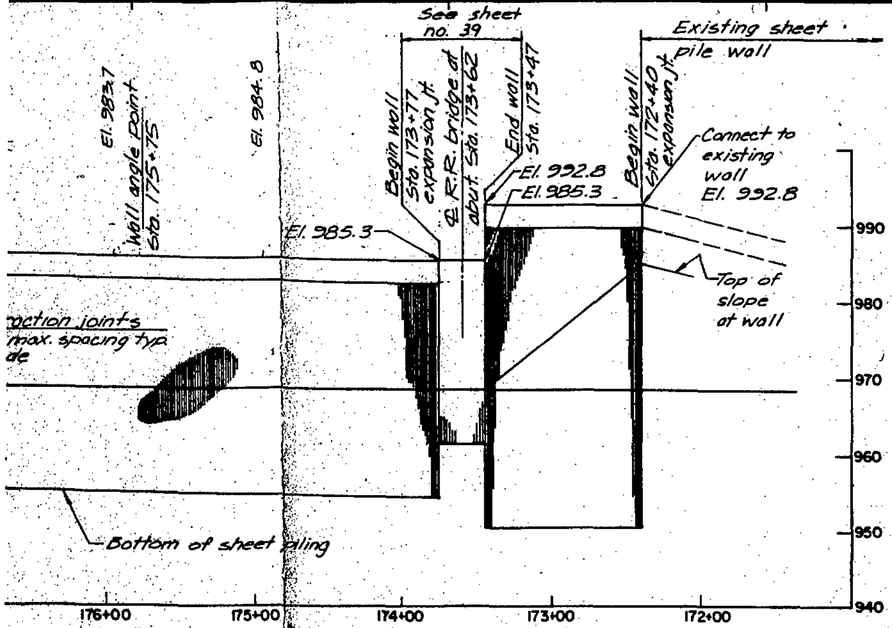
sheet pile
steel

(T)YPICAL SECTION THRU SHEETPILE WALL

4 0 4 8
$\frac{1}{4}$" = 1'-0"

2

SYMBOL
WHKS – Professional Engineer
Mason City, Ia. – Rochester, Minn.
DESIGNED BY: J.A.J.
DESIG
DRAWN BY: D.L.E./K.R.R.
CHECKED BY: J.D.S./D.O.
SUBMITTED BY:
APPR



-ors to be upset to
-diameter at the anchor

-nchors to be double
-on protected, A36 steel
-k building at Sta 177+50
to be removed.

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Minn. – Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: J.A.J.
DRAWN BY: D.L.F./K.R.R.
CHECKED BY: J.D.S./D.O.
SUBMITTED BY:

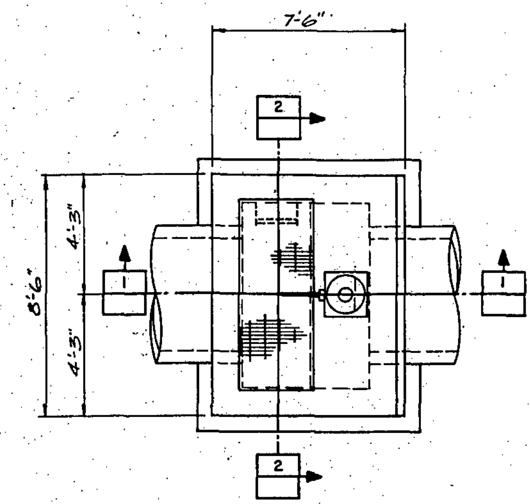
DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
LEFT BANK FLOODWALL
STA. 172+40 TO STA. 186+25

APPROVED BY:
DATE: DECEMBER 1986
SCALE: AS SHOWN
DRAWING NUMBER: M30-R-61/7
SHEET 43 OF 45

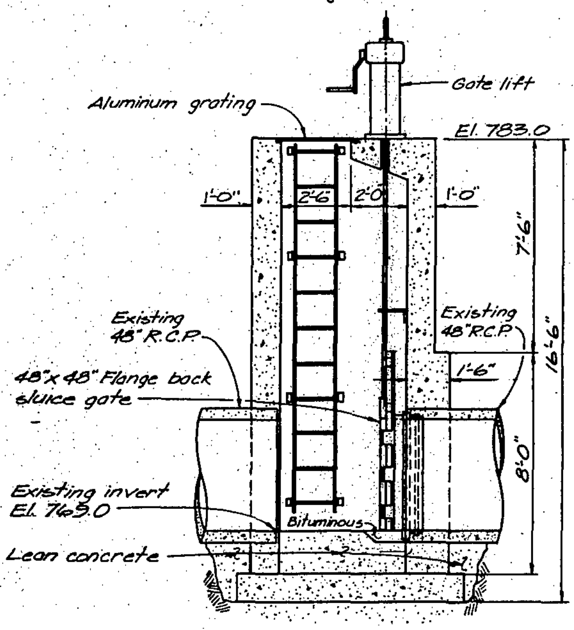
SAFETY PAYS

3

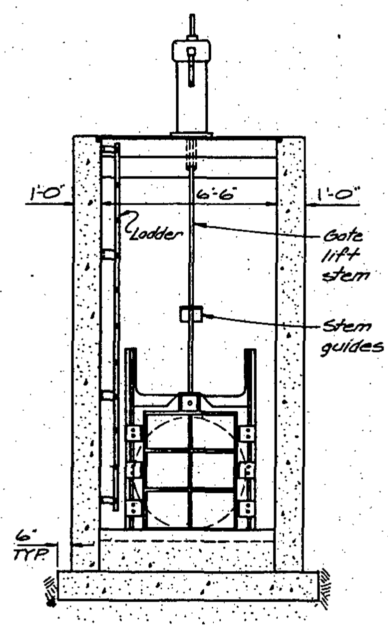
PLATE 43



PLAN
GATE WELL (A)
2 0 2 4 6
$\frac{3}{8}$" = 1'-0"

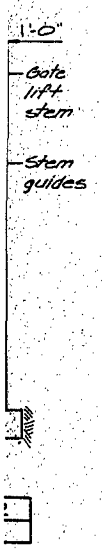


SECTION 1
GATE WELL (A)
2 0 2 4 6
$\frac{3}{8}$" = 1'-0"



SECTION 2
GATE WELL (A)
2 0 2 4 6
$\frac{3}{8}$" = 1'-0"

D E F G H



SYMBOL	DESCRI

WHKS – Professional Engineers & Planners
Mason City, Ia. – Rochester, Minn. – Dubuque,

DESIGNED BY: D.J.P.

DRAWN BY: D.L.F.

CHECKED BY: D.J.P.

SUBMITTED BY:

CHIEF ED-D BRANCH

CHIEF ED-GH BRANCH

DESIGN MEMORA
FLOOD

APPROVED BY:

SAFETY PAYS

2

D E F G

G H J

6

5

4

3

2

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Minn. - Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: D.J.P.

DRAWN BY: D.L.F.

CHECKED BY: D.J.P.

SUBMITTED BY:
CHIEF ED-D BRANCH
CHIEF ED-GH BRANCH

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
DETAILS

APPROVED BY:
CHIEF ENGR. DIVISION

DATE: DECEMBER 1986

SCALE AS SHOWN

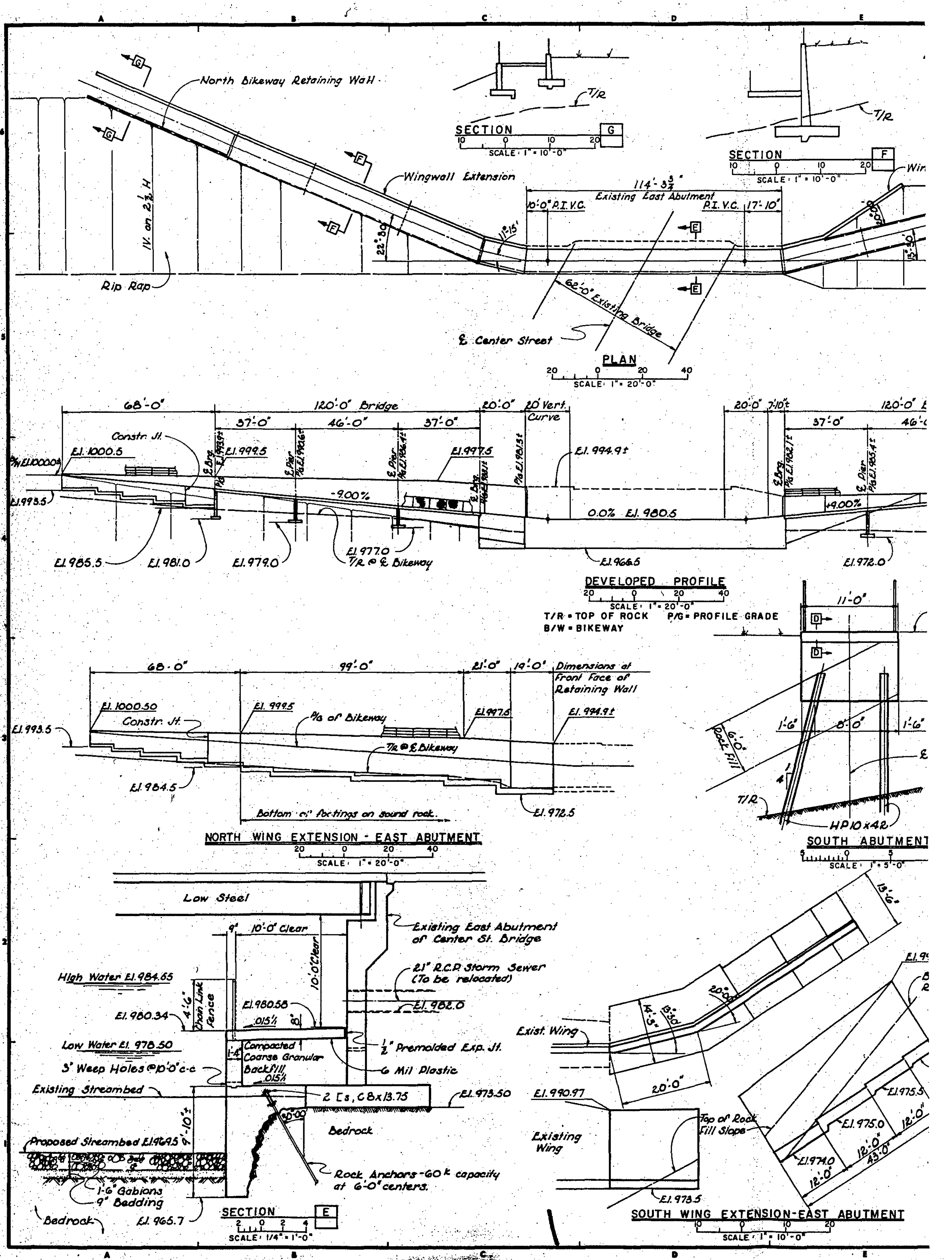
SPEC. NO.

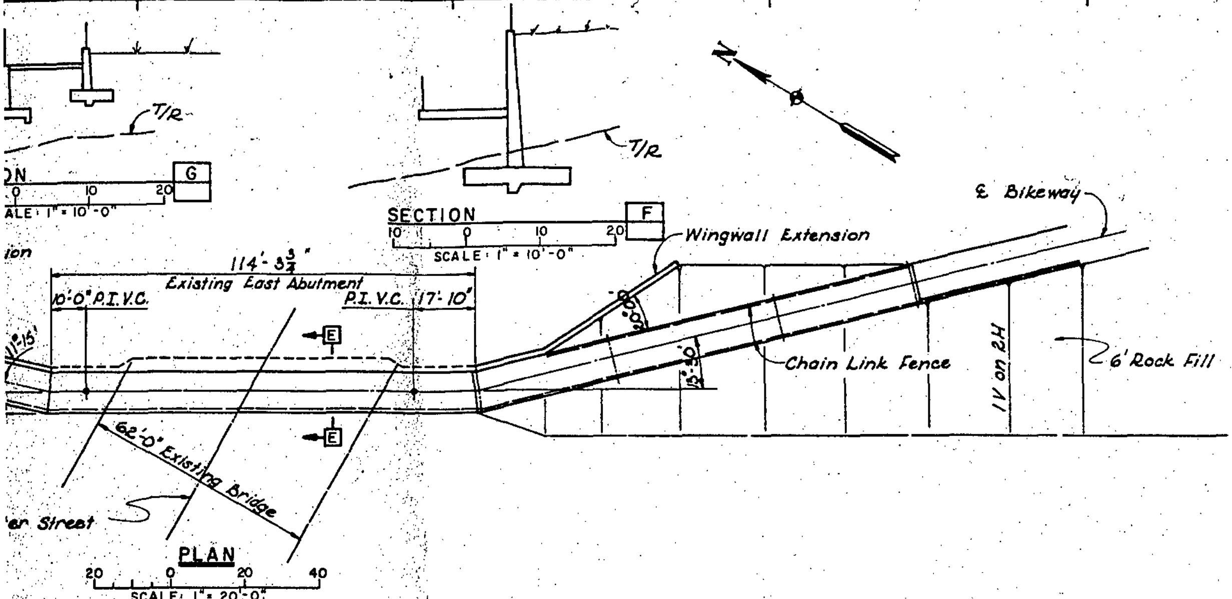
DRAWING NUMBER
M30-R-61/8
SHEET 44 OF 45

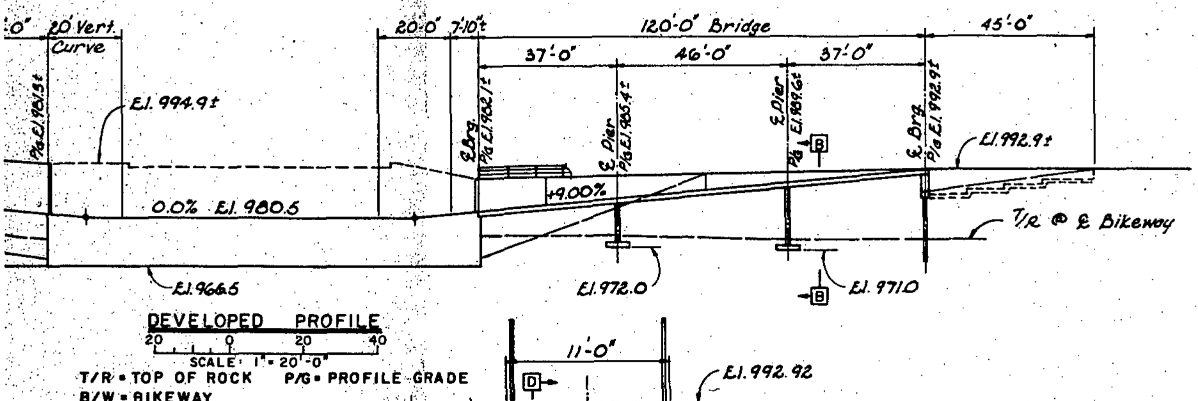
SAFETY DAYS

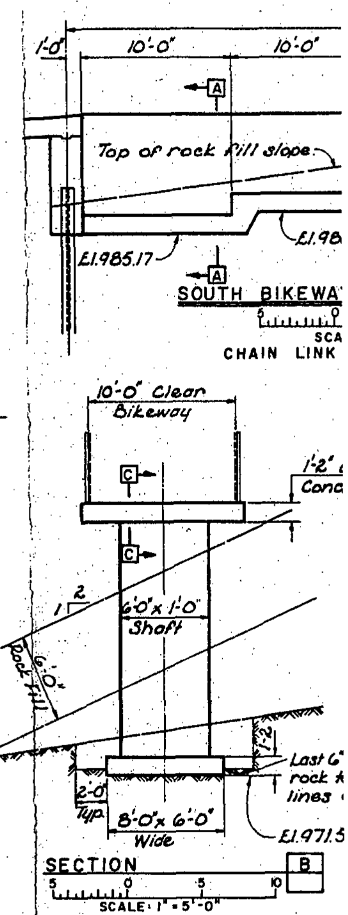
3

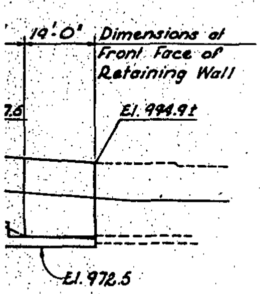
G

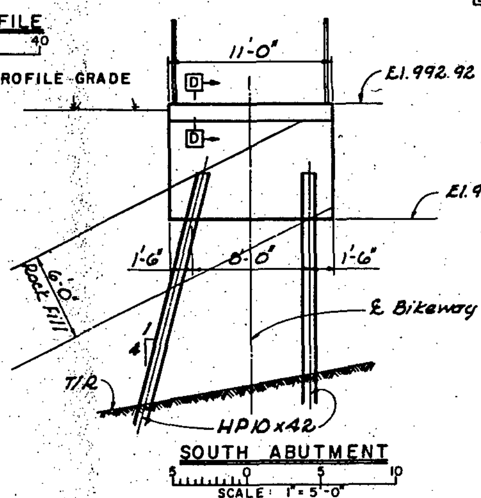

North Bikeway Retaining Wall
Wingwall Extension
1V. on 2½ H
22°30'
11°15'
Rip Rap
SECTION G
SCALE: 1" = 10'-0"
SECTION F
SCALE: 1" = 10'-0"
T/R
114'-3¾"
Existing East Abutment
10'-0" P.I.V.C.
P.I.V.C.
17'-10"
62'-0" Existing Bridge
℄ Center Street
PLAN
SCALE: 1" = 20'-0"
68'-0"
120'-0" Bridge
37'-0"
46'-0"
37'-0"
20'-0"
20' Vert. Curve
7'-10"±
Constr. Jt.
El. 1000.5
El. 999.5
El. 997.5
El. 994.9±
-9.00%
0.0% El. 980.5
+9.00%
El. 993.5
El. 985.5
El. 981.0
El. 979.0
El. 977.0 T/R @ ℄ Bikeway
El. 966.5
El. 972.0
DEVELOPED PROFILE
SCALE: 1" = 20'-0"
T/R = TOP OF ROCK
P/G = PROFILE GRADE
B/W = BIKEWAY
68'-0"
99'-0"
21'-0"
19'-0"
Dimensions at Front Face of Retaining Wall
El. 1000.50
El. 999.5
El. 997.5
El. 994.9±
P/G of Bikeway
T/R @ ℄ Bikeway
El. 984.5
El. 972.5
Bottom of Footings on sound rock.
NORTH WING EXTENSION - EAST ABUTMENT
SCALE: 1" = 20'-0"
11'-0"
1'-6"
8'-0"
1'-6"
6'-0" Rock Fill
HP10x42
SOUTH ABUTMENT
SCALE: 1" = 5'-0"
Low Steel
Existing East Abutment of Center St. Bridge
10'-0" Clear
10'-0" Clear
21" R.C.P. Storm Sewer (To be relocated)
High Water El. 984.65
El. 980.34
4'-6"
Chain Link Fence
El. 980.58
El. 982.0
.015'/'
Low Water El. 978.50
Compacted Coarse Granular Backfill
1/2" Premolded Exp. Jt.
6 Mil Plastic
3" Weep Holes @ 10'-0" c-c
Existing Streambed
2 [s, C8x13.75
El. 973.50
Bedrock
Proposed Streambed El. 969.5
1'-6" Gabions
9" Bedding
Rock Anchors - 60k capacity at 6'-0" centers.
Bedrock
El. 965.7
SECTION E
SCALE: 1/4" = 1'-0"
13'-6"
20°00'
14'-3"
13'-0"
Exist. Wing
20'-0"
El. 990.97
Existing Wing
Top of Rock Fill Slope
El. 973.5
El. 975.5
El. 975.0
El. 974.0
12'-0"
12'-0"
12'-0"
43'-0"
SOUTH WING EXTENSION-EAST ABUTMENT
SCALE: 1" = 10'-0"











WALL DIMENSIONS						
H	B	A	T	W	D	
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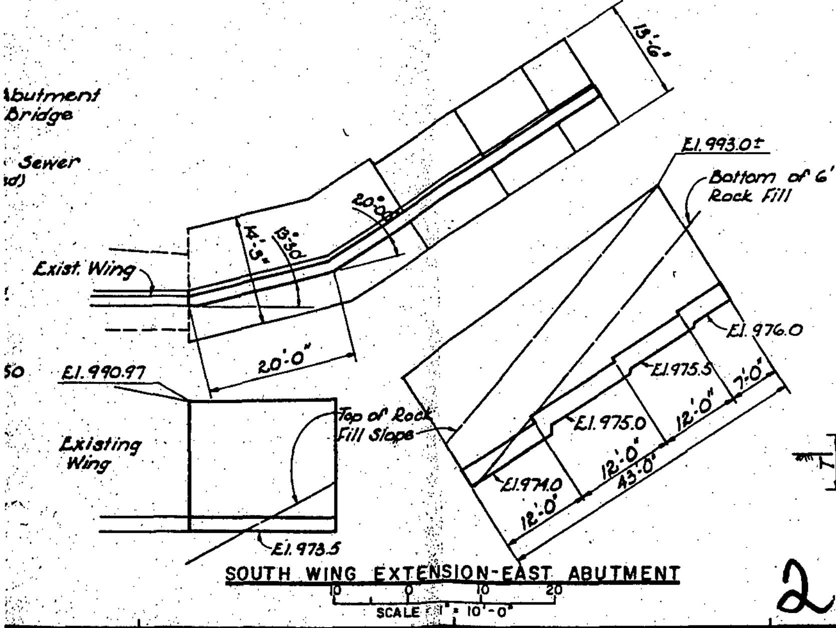
9'-0"	7'-3"	1'-11"	1'-8"	1'-6¾"	1'-0"	
11'-0"	9'-0"	2'-7"	1'-9"	1'-8¼"	1'-0"	
13'-0"	10'-6"	3'-11"	1'-11"	1'-9¾"	1'-0"	
15'-0"	12'-3"	4'-4"	2'-7"	2'-5½"	1'-0"	
17'-0"	13'-6"	4'-6"	2'-9"	2'-6¾"	1'-0"	
19'-0"	15'-0"	6'-4"	2'-11"	2'-0¼"	1'-0"	
21'-0"	16'-3"	6'-5"	3'-0"	2'-9¾"	1'-0"	
24'-0"	18'-6"	7'-3"	3'-2"	3'-0"	1'-0"	

Beve

Top



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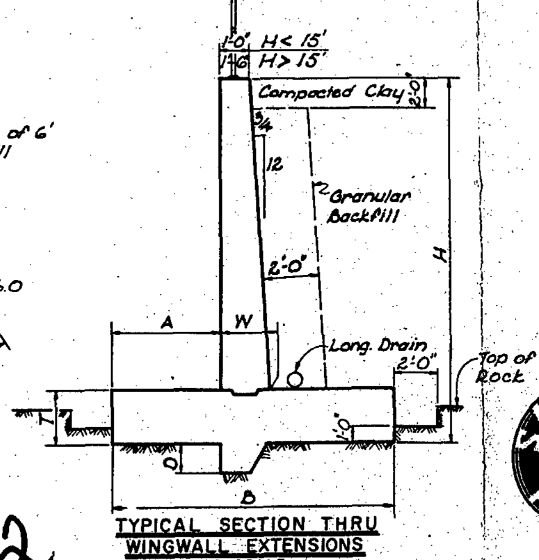


SYMBOL

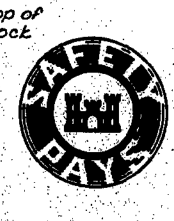
WHKS - Profes
Mason City, Ia.

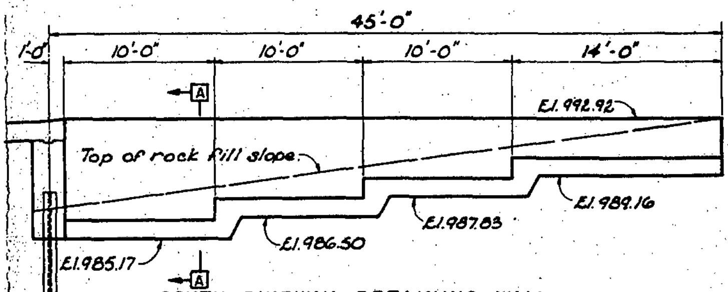
DESIGNED BY: G.E.

DRAWN BY: L. M.

CHECKED BY: C. E.

SUBMITTED BY:

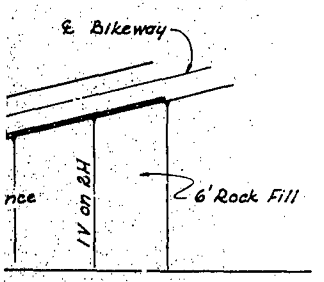


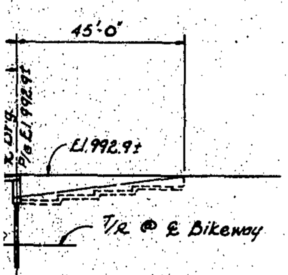


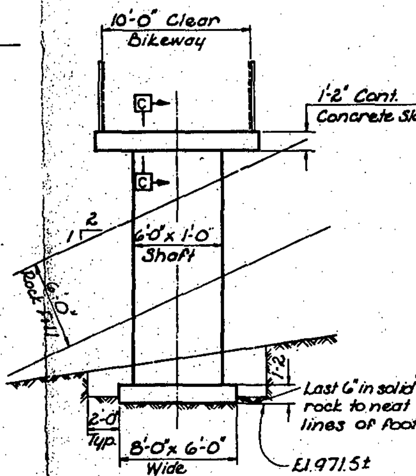
SOUTH BIKEWAY RETAINING WALL

SCALE: 1" = 5'-0"

CHAIN LINK FENCE NOT SHOWN

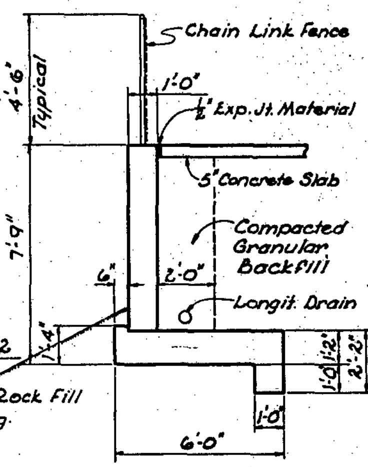






SECTION B

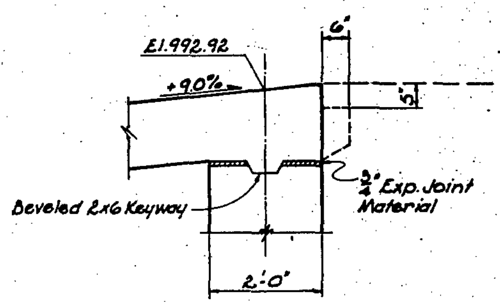
SCALE: 1" = 5'-0"



SECTION A

SCALE: 3/8" = 1'-0"

DETAILS FOR NORTH BIKEWAY WALL SIMILAR.



SECTION D

SCALE 3/4" = 1'-0"

WALL DIMENSIONS						
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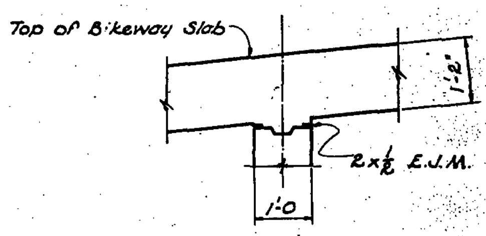
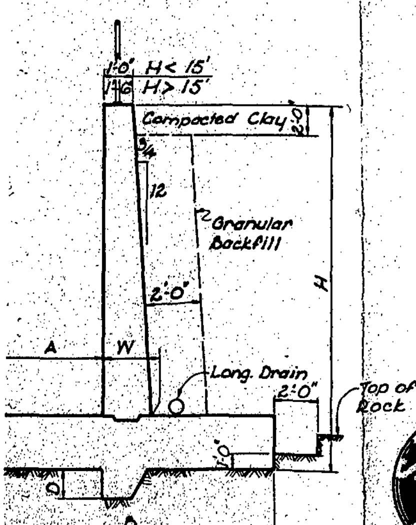
7'-0"	5'-9"	1'-3"	1'-6"	1'-5½"	1'-0"	
9'-0"	7'-3"	1'-11"	1'-8"	1'-6¾"	1'-0"	
11'-0"	9'-0"	2'-7"	1'-9"	1'-8¼"	1'-0"	
13'-0"	10'-6"	3'-11"	1'-11"	1'-9¾"	1'-0"	
15'-0"	12'-3"	4'-4"	2'-7"	2'-5½"	1'-0"	
17'-0"	13'-6"	4'-6"	2'-9"	2'-6¾"	1'-0"	
19'-0"	15'-0"	6'-4"	2'-11"	2'-8¼"	1'-0"	
21'-0"	16'-3"	6'-5"	3'-0"	2'-9¾"	1'-0"	
24'-0"	18'-6"	7'-3"	3'-2"	3'-0"	1'-0"	



SECTION C

SCALE: 3/4" = 1'-0"



TYPICAL SECTION THRU WINGWALL EXTENSIONS

NO SCALE

3

SYMBOL	DESCRIPTION	DATE	APPROVAL

WHKS - Professional Engineers & Planners
Mason City, Ia. - Rochester, Mn. - Dubuque, Ia.

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: G.E.G.
DRAWN BY: L.M.G.
CHECKED BY: C.E.W.
SUBMITTED BY:
CHIEF EDSD BRANCH
CHIEF EDGN BRANCH

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE IB
BIKE PATH UNDERPASS
CENTER STREET BRIDGE

APPROVED BY: Robert L. Post
CHIEF ENGR. DIVISION

DATE: DECEMBER 1986

SCALE: AS SHOWN

DRAWING NUMBER M30-R-61/9

SHEET 45 OF 46

PLATE 45

APPENDIX A

HYDRAULIC DESIGN

APPENDIX A
HYDRAULICS

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TABLES

PLATES

PLATE

SILVER LAKE DAM

1. GENERAL Several modifications are proposed for the Silver Lake Dam. The most significant is removing a portion of the existing fixed crest spillway and installing a hinged leaf gate (Bascule-type). Other changes are adding de- icing and motorizing equipment to the existing tainter gates and performing modifications to the existing stilling basins and downstream erosion protection. The addition of the hinged leaf gate requires changing the operating plan of the dam. The reason for the addition of this gate is to lower upstream flood elevations. The modified dam is designed to insure that the headwater elevation for the design discharge of 22,000 cfs is below elevation 980.0. The new gate is to be lowered during floods. In the full down position the top of the gate is to be at elevation 969.0. In its normal, full up, position it is to be at the same elevation as the existing fixed crest, 974.1. The changes to the existing 3 tainter gates are required to insure that they can be opened during floods. The design is based on the three tainter gates being full open for the design discharge. The modifications to the stilling basin and scour protection downstream of the spillway are needed because the existing protection would not be adequate for the increased discharge over the spillway after the hinged leaf gate is added. The existing erosion protection downstream of the tainter gates was also found to be inadequate and will be upgraded.

2. EXISTING OPERATING PLAN The existing Silver Lake Dam is operated by personnel at the Rochester Power Plant. Under the existing plan the water level is monitored at the power plant and when it exceeds elevation 976.5, a crew is sent to open the tainter gates. They communicate with the power plant by radio to get gate settings which maintain the pool at about 976.5 until the tainter gates are full open. As the flow and pool elevation go down the tainter gates are returned to the closed position. The utility company has had problems with the erosion protection downstream of the tainter gates. They have placed very large riprap which has been displaced when the gates are opened.

3. PROPOSED OPERATING PLAN The proposed operating plan is based on trying to match the existing plan as much as possible. As for the existing plan, the gates will be left in their normal setting until the pool elevation exceeds 976.5. At that time the hinged leaf gate will be gradually lowered to maintain 976.5. When the hinged leaf gate is fully down the tainter gates will start to be opened. The tainter gates will be gradually opened to maintain 976.5 until the gates are full open. As the flow and pool go down the tainter gates will be gradually closed to maintain 976.5. After the tainter gates are fully shut the hinged leaf gate will be gradually raised to maintain 976.5 until it is in the full up position. The order of lowering the hinged leaf gate before opening the tainter gates as the flow increases and closing the tainter gates before raising the hinged leaf gate during the receding flow is important to insure the downstream erosion protection performs as required. The impacts of other gate operation procedures is discussed later in this appendix. Table A-1 lists the proposed operating plan and the discharges that would be passing at the different phases of the operation. Table A-2 lists the sequence of operation during the design flood and the time each step would have to be performed at.

TABLE A-1
PROPOSED OPERATING PLAN

Pool Elevation	Gate Setting: Tainter Gate	Gate Setting: Hinged Leaf	Discharge (CFS)	Annual Prob. of Occurrence
Rising Discharge				
<976.5	Closed	Full Up	<2000	>50%
976.5	Closed	Start to Lower	2000	>50%
976.5	Start to Open	Full Down	11000	7%
976.5	Full Open	Full Down	14000	3%
980.0	Full Open	Full Down	22000	Design(.5%)
Falling Discharge				
>976.5	Full Open	Full Down	>14000	<3%
976.5	Start to Close	Full Down	14000	3%
976.5	Full Closed	Start to Raise	11000	7%
976.5	Full Closed	Full Up	2000	>50%
<976.5	Full Closed	Full Up	<2000	>50%

The probability column in the above table is the percent chance of that discharge being equaled or exceeded in any year. For example, there is a 3% chance that in any year the discharge will equal or exceed 14000 cfs. Thus, there is a 3% chance that in any year the tainter gates will have to be full open. These frequencies are based on project conditions with the SCS reservoirs, Plate D-17 of DM No. 1. The pool elevations for different discharges are based on design (high roughness) conditions.

TABLE A-2
SILVER LAKE DAM OPERATION FOR THE DESIGN FLOOD

Discharge	Time	Gate Setting: Tainter Gate	Gate Setting: Hinged Leaf
˘200	0-12 hrs	Full Closed	Full Up
2000	13.5 hrs	Full Closed	Start to Lower
11000	16.0 hrs	Start to Open	Full Down
14000	18.0 hrs	Full Open	Full Down
22000	26.0 hrs	Full Open	Full Down
14000	31.5 hrs	Start to Close	Full Down
11000	33.5 hrs	Full Closed	Start to Raise
2000	46.5 hrs	Full Closed	Full Up

Times are based on the design flood hydrograph as shown on Plate D-4 of DM No 1. Note that the tainter gates will be full open with the hinged leaf gate down from time 18.0 to 31.5 hours, a total of 13.5 hours. It can also be seen that the hinged leaf gate goes from its full up to full down position in 2.5 hours but it goes back to the full up position in 13 hours (46.5 - 33.5).

4. DESIGN HEADWATER AND TAILWATER RATING CURVES The design headwater and tailwater rating curves are shown on Plate A-1. These tailwater curves are from the HEC-2 model for the downstream reach. The headwater curves are based on the proposed operating plan. The hinged leaf weir in its down position is

to form an ogee section with a total effective flow width of 140.5 ft. As stated in the next paragraph, the ogee section is designed for a headwater of 976.5 and a discharge of 11000 cfs. For the headwater of 976.5, a weir coefficient of 3.82 was obtained from Figure 249 of Design of Small Dams. The coefficient was varied for different heads by Figure 250 of this reference and varied for the 1:1 upstream slope by Figure 251. The weir coefficient was reduced for submergence by HDC 111-4. The effective length of the spillway was reduced for end contraction by Figure 4 on page 373 of Design of Small Dams. An orifice coefficient of 0.8 was used for the tainter gates. The total flow area used for the tainter gates was 642 square feet. If the tainter gates were open for low headwater elevations or opened before the hinged leaf gate were lowered (both of these conditions are not in accordance with the operating plan), flow through them could be weir flow, this condition was checked using a weir coefficient of 3.0 and a weir elevation at the gate sill of 964.8.

5. SPILLWAY CREST SHAPE The existing spillway is an ogee crest and the proposed spillway is also to have an ogee section. The ogee section is the most hydraulically efficient and thus minimizes the required lowering of the existing spillway. Various combinations of discharges and gate settings were considered to determine the worst case for the spillway design. For the design peak discharge of 22000 cfs, the hinged leaf is to be in the full down position and the three tainter gates are to be full open. For the gates in this position, the head drop across the structure is less than 1.5 ft for all discharges (see Plate A-1) and from HDC 111-4 it was found that there would either be a drowned jump or no jump at all. For these conditions the exact shape of the crest is not of much importance since a jet never forms or only follows the crest for a short distance. The most severe case for the crest shape is when the hinged leaf gate is full down but the tainter gates are still fully closed. For the proposed operating plan this corresponds to a discharge of 11000 cfs, a headwater of 976.5 and a tailwater of 973.0 (see Plate A-1). The tailwater of 973.0 is based on low frictions factors downstream of the dam since that is the most severe case-highest head differential. The crest shape is shown on Plate A-2. The design is based on Figure 247 of Design of Small Dams. The procedures used to determine the type of flow conditions through the tainter gates followed those suggested in Chapter 5 of the draft EM on Hydraulic Design of Navigation Dams.

EROSION PROTECTION

6. Tainter Gates. Erosion protection includes required modifications to the existing stilling basins and riprap/gabion protection downstream. The flow through the tainter gates and over the spillway were treated separately. The following conditions, or combinations of these conditions, were examined: hinged leaf gate up, hinged leaf gate down, all three tainter gates full open, all three tainter gates open one-fourth, one tainter gate full open, one tainter gate open one-half and one tainter gate open one-fourth. Note that several of these conditions should never occur if the proposed operating plan is followed. However, these conditions were studied in part to determine an acceptable operating plan and are discussed here in order to show the possible impacts if the operating plan is not followed. Based on this study it was found that if the tainter gates were opened while the hinged leaf gate was in the up position, the tailwater below the tainter gates would almost always be too low for a hydraulic jump to form. This was based on the proposed stilling basin at elevation 962.0. This elevation is the same as the channel bottom through the downstream bridge and is 1.0 ft below the elevation of the existing end sill. Using a higher elevation than 962.0 would it more difficult

to insure a jump downstream of the gates. Using a lower elevation would create a need for transitions from the existing basin to the extension and from the concrete extension to the channel bottom under the bridge. The proposed plan is to add a concrete pad to the end of the existing stilling basin. This pad is to work as an extension of the existing basin. Thus, the pad should be at a somewhat similar elevation as the existing basin to insure that they work as one. The required tailwater elevations for the tainter gates if the hinged leaf is in the up position are shown on Plate A-3. From this plate it can be seen that the only gate position that results in an acceptable tailwater is if all three tainter gates are open one-fourth and the pool elevation is above about 979.0. This plate does not show the required tailwater curves for the case where only one of the tainter gates is being operated and the other two are left closed. This is because the required tailwater is even higher than for all three gates operated together. The fact that the tailwater is inadequate for a jump downstream of the tainter gates if the hinged leaf is in the full up position is verified by the existing conditions downstream of the tainter gates. For existing conditions the utility company has found that opening the tainter gates results in a very high velocity downstream with attendant displacement of very large riprap and excessive scour. For proposed conditions the velocities downstream of the tainter gates would be even worst than existing if the hinged leaf gate were left up when the tainter gates were opened. This is because the tailwater would be lower for proposed conditions since the downstream channel is to be enlarged.

7. Based on the above study it was considered necessary to require that the tainter gates not be opened until the hinged leaf gate be in the full down position. With the hinged leaf lowered before the tainter gates are opened it was found that there would be adequate tailwater to get a hydraulic jump below the tainter gates as long as the tainter gates are closed before the pool recedes below normal pool elevation of 974.1, as shown on Plate A-4. From this plate it can be seen that if the three tainter gates were open when the pool elevation dropped below about 972 (5600 cfs), the available tailwater would be less than that needed for a jump to form below the tainter gates. Without this jump the jet from the gates could attack the channel downstream of the concrete protection.

8. To determine the required length of stilling basin and erosion protection downstream of the tainter gates, two conditions were examined: all three tainter gates full open and only one tainter gate full open with the other two closed. Both of these conditions also assume the hinged leaf gate full down. The worst case for the stilling basin design (longest basin) was found to be for the design discharge of 22000 cfs and all three tainter gates full open. For this case the low friction tailwater is 977.8 and the corresponding headwater is 979.4. This condition gave a Froude number of 3.0 and a velocity of 30.3 fps for the flow entering the basin. The end sill velocity is 6.1 fps and the required basin length is 63.6 feet from Figure B-15 of Design of Small Dams. For low Froude numbers, a USBR Type 1 basin is acceptable as shown on page 396 of Design of Small Dams. For the design flow the existing baffle blocks were not considered effective due to the high tailwater submergence and Froude number. The highest end sill velocity was 8.1 fps for the condition when all three tainter gates are full open, the hinged leaf gate is down and the headwater is at 974.4. The reason that a headwater of 974.4 gives the worst end sill velocities can be seen from the headwater curve for the three open tainter gates on Plate A-4. From this curve it can be seen that headwaters above 974.4 do not increase the discharge through the tainter gates significantly but do increase the flow over the hinged leaf gate. This results

in a higher tailwater and lower end sill velocities for the higher headwater elevations. According to the operating plan the tainter gates should not be open when the headwater is at 974.4, however, using that for the design does not significantly change the erosion protection but does add a factor of safety in case the gates are not always operated as planned.

9. Hinged Leaf Gate. It was decided that for cost reasons the proposed design would use as much of the existing stilling basin as possible. The basin for the hinged leaf spillway was set at the same elevation as proposed for the tainter gates. For this basin elevation the tailwater is adequate to form a jump downstream of the spillway for any assumed operation of the tainter gates, see Plate A-5. For flows less than 7600 cfs the jet would strike the basin floor upstream of the existing baffle blocks, see Plate A-6. For these conditions the required tailwater depth was reduced to 0.9 d2 to give credit to the blocks. The profiles on Plate A-7 assume that the gate is operated to maintain a pool of 976.5, per the operating plan. If the gate were lowered too fast and the pool was drawn down below 976.5, there would be a greater certainty of a jump forming for all flows. Conversely, if the gate were lowered too slowly and the pool were allowed to go above 976.5 before the gate was fully down, the performance in the stilling basin could suffer.

10. The worst case for the stilling basin design is a discharge of 11,000 cfs at a pool of 976.5 and a tailwater of 973.0. This resulted in a maximum velocity of 27.4 fps , a Froude number of 2.85 and a d2 of 10.2 feet. The existing baffle blocks were not considered effective for the higher discharge due to the low Froude number and the high submergence. For low Froude numbers the USBR recommends a type 1 basin. This type of basin is a flat concrete slab without an end sill. The required length was determined for different flow conditions from Figure B-15 of Design of Small Dams. The longest computed length was 53 ft. A length of 64 ft was needed below the tainter gates and the same length is proposed below the hinged leaf gate. Thus, the concrete slab is to go the full width of the channel. A sketch of the proposed design is shown on Plate A-7.

11. The maximum velocity over the end sill downstream of the spillway was computed to be 7.6 fps. This is the same as the velocity through the bridge just downstream of the dam and therefore the erosion protection proposed for the channel bottom under the bridge should be adequate at the end sill. The protection under the bridge was sized using the high turbulence curve of HDC 712-1. This same protection is to be used downstream of the slab at the tainter gates.

12. VIBRATION-PRESSURE To reduce the chance of flow induced vibration of the hinged leaf gate, flow splitters are to be used. Spacing should be 50 to 70 percent of the fall height or about 7 feet since for low discharges the fall height is about 12 feet, see Plate A-7. The recommended spacing is from an article by Schwartz in the November 1964 ASCE Journal of Hydraulic Engineering. Even with the splitters there could still be some vibrations and pressure pulses; this is to be considered in the structural/mechanical design of the gates.

CHANNEL DESIGN

13. GENERAL The Zumbro River channel is to be deepened and widened from just downstream of the Silver Lake dam to the Third Ave bridge. The design presented in this Feature Design Memorandum is a refinement of the design

presented in the 1982 General Design Memorandum. The hydraulic study for this FDM included a study of different designs to determine the most cost effective design. The study also included refinements to this design needed for geotechnical, structural or layout reasons. Normally the cost effective analysis is done in the General Design Memorandum hydraulic studies, however, as stated on page A-1 of the 1982 GDM, this analysis was delayed until the feature design memorandums for this project. The proposed work does not include any high levees or floodwalls. In one area, the right bank from about station 175+00 to 182+00, the proposed sheet pile wall is to project slightly above the natural ground level to insure adequate freeboard. The proposed design includes riprap and gabion scour protection. The gabions are proposed at the North Broadway, Center Street and railroad bridges. Anticipated hydraulic studies for the plans and specifications include determining the impact of changes to the design that others may propose. The geotechnical engineers have indicated that some of the proposed 1V:2H rock fill slopes will probably have to be changed to a flatter slope for stability. Also, the proposed gabions are expected to have a very high maintenance cost and hydraulic alternatives should be examined again for the plans and specifications.

14. DESIGN DISCHARGE AND FREQUENCY The total Rochester flood control project includes channel modifications within the city proposed by the Corps of Engineers and a series of small reservoirs proposed by the Soil Conservation Service. These reservoirs are proposed for the tributaries to the South Fork Zumbro River. The combination of the channel work and the reservoirs is intended to provide protection from the same flood discharges used in the Phase 1 and Phase 2 General Design Memorandums. At the time of the Phase 1 report these discharges were estimated to be the 1 percent (100-year) flood. Reanalysis of the frequency curves for the Phase 2 report resulted in these discharges having a decreased likelihood of occurring. Thus, the project will now provide protection from floods in excess of the 100-year. Details on the frequency analysis are shown in Appendix D of the Phase 2 GDM. For reach 1b the various design discharges and frequencies are shown in Table A-3.

TABLE A-3
REACH 1B DESIGN DISCHARGES

Location	Design Discharge	Frequency of Occurrence
Silver Lake Dam to Silver Creek	22,000 cfs	0.5% - 200 year
Silver Creek to Bear Creek	21,500 cfs	0.45% - 220 year
Upstream of Bear Creek	16,800 cfs	0.5% - 200 year

15. FREEBOARD For this project, freeboard is considered the vertical distance between the design flood profile and the elevation where significant damages start. The design flood is allowed to exceed the top of bank elevation is some areas as long as it does not create significant flooding damages. Shallow flooding of roads was not considered significant damage. The hydraulic design attempted to provide a minimum of 2.0 feet of freeboard. However, this was not always obtained. In some areas the freeboard is close to zero. The buildings with less than 2.0 feet of freeboard are all located some distance from the channel and should not be subjected to high velocities. When determining the required freeboard, the nature of the proposed modifications and of the design flood hydrograph were considered. Because the proposed work

is channel modification rather than levee/floodwalls the consequences of flood stages slightly in excess of the design should not be catastrophic. This allows the use of lessor freeboard. Also, the design flood hydrograph has a very sharp peak and thus the duration of flooding is small. While the short duration of flooding has little impact on the damages to residences or commercial establishments it does make shallow flooding of roads of less importance. The design hydrograph at the Silver Lake Dam peaks at 22,000 cfs and only exceeds a discharge of 18,000 cfs for 6 hours. The exact locations of low freeboard areas are provided in the later parts of this appendix.

16. CHANGES FROM THE PHASE 2 GDM The proposed channel design is very similar to that presented in the Phase 2 GDM. The changes that have been made include some minor changes in alignment and size made for layout considerations, a general lowering of the channel bottom with an attendant narrowing of the channel bottom, the addition of a bikepath along the right bank and changes in some of the side slopes. The lowering of the bottom is discussed in detail in the next paragraph of this appendix. The City of Rochester proposed a bikepath along the right bank that goes under the Seventh St, Center St and Third Ave bridges. This bikepath was added to the HEC-2 model and was found to have very little impact on flood profiles and velocities and was accepted for the design. A higher wall was added along the right bank in the area of the cemetery (about station 170+00 to 174+50) in order to keep the top width narrow and to improve aesthetics. The right bank slope from the RR bridge to Center Street was changed from a vertical wall to a riprapped slope. This was done due to higher bed rock elevations in this area than were anticipated. The high bed rock made driving of sheet pile impractical. The right bank in the Mayo Park area (about station 188+00 to 193+00) was changed from a 1V:3H riprapped slope to a 1V:2H rock fill. This was done to minimize the fill in this area since the existing bank is steeper than 1V:2H. The right bank area at Mayo Park may go back to a flatter slope for the plans and specifications since the 1V:2H slopes may not be stable.

17. COST EFFECTIVE ANALYSIS

As part of the hydraulic analysis for this reach a cost effective analysis was done. This analysis looked at three different channel designs: the design shown in the Phase 2 GDM, a design with a lowered and narrowed bottom, and a design with different side slopes than the Phase 2 design. All three of these were to be designed to provide the same design flood profile. The costs of the three alternatives were developed, the costs for all three were fairly close but the lowered bottom alternative had the least cost and was selected. As discussed in the paragraph 19, the study by WES had recommended a lowering of the bottom since their model predicted scour for the Phase 2 design in this reach. The Phase 2 and the new design bottom slopes are shown in Table A-4.

TABLE A-4
PHASE 2 AND PROPOSED BOTTOM SLOPES

Location	Bottom Slope Phase 2	Bottom Slope Present Design	Bottom Elevation Phase 2	Bottom Elevation Present Design
Silver Lake Dam			962.8	962.8
to	.001538	.001538		
Sta 154+05			967.0	967.0
to	.001179	.000806		
Sta 186+10			970.8	969.6
to	.000376	.000806		
Sta 214+71(Reach 2a)			971.9	971.9
to	.000376	.000376		
Sta 221+46(Reach 2a)			972.1	972.1

The maximum lowering of the bottom is at station 186+10, where the difference is 1.2 feet.

18. A potential problem with doing the cost effective analysis reach by reach instead of for the total project, is that the hydraulic design of one reach depends on the design of adjacent reachs. For the analysis done for this reach it was assumed that the design water surface elevations at the confluence with Bear Creek and at the upstream end of the reach could not be changed from those used in the Phase 2. These elevations are the starting elevations for the Bear Creek design and for the reach 2a design. However, for this project different reachs are fairly independent and doing a cost effective analysis reach by reach appears to be acceptable. The reachs are fairly independent because of the way they were broken up and because of the high velocities and steep slopes in this project. The break between this reach and the next reach upstream, 2a, is the point where the Phase 2 channel design makes a significant change from mostly riprap slopes with a sand bottom to a channel with concrete sides and a rock bottom in reach 2a. The downstream end of reach 1b is at the Silver Lake dam and is a natural point for the break in reachs.

19. SEDIMENT ANALYSIS As part of the Phase 2 study, a sediment analysis was performed by the Waterways Experiment Station. The report was "Sedimentation Study for the Rochester, Minnesota, Flood-Control Project," by David T. Williams, October 1983, MP HL-83-7. The study was done using the HEC-6 program. The report generally found that the design presented in the Phase 2 Memorandum would not be adversely affected by sedimentation or generalized scour and that the sediment removal maintenance requirements would be reasonable. The sediment study found that a low flow channel was not needed for reach 1b since for low flow the entire reach is in the pool of the Silver Lake dam. The model did predict some general bed scour in the reach from the C&NW RR bridge in this reach to the 4th bridge which is just upstream of this reach. The present design has lowered the bottom elevation in this area and this should reduce the amount of scour and subsequent deposition in Silver Lake. Lowering of the bottom in this area was recommended by Mr. Williams. Since the changes to the design have been in the direction recommended by the WES study, the HEC-6 model was not rerun with the new geometry. If significant changes are made to other reachs it is anticipated that the HEC-6 model for the entire project will be modified and rerun.

20. DESIGN DIMENSIONS AND CONSIDERATIONS

The following paragraphs discuss the hydraulic design in detail for each portion of this reach. These paragraphs detail the points where freeboard is at a minimum. These points control the channel design. The HEC-2 input and output for the design flood is included as an attachment to this appendix. The comment cards in the model include the design channel dimensions for each cross-section. In some cases one bank of a section may have two parts, for example a riprapped slope up to a vertical wall; in those cases the comment cards just state the more significant of the two parts. The loss coefficients used for the channel and the bridges are shown in the input and output. The Mannings "n" used for the channel was .035. The impact of use of a lower friction factor was also checked using an "n" of .025. The starting water surface for the low "n" profile was taken from the headwater rating curve for the Silver Lake dam that was based on low tailwater. The computed velocities for the low "n" run are shown on Plate A-8. Froude numbers were computed for each section where the velocity exceeded 10 fps. The highest velocity and Froude numbers were through the D.M & E RR bridge and were 14.0 fps and .74. This Froude number is sufficiently below 1.0 to assure there will not be excessive wave action or instability. However, this bridge is a significant restriction and if replaced in the future it should have a larger opening.

21. North Broadway Bridge. The channel size and erosion protection for this bridge were determined in the reach 1a study. The proposed channel size is that which fits the existing opening. From Table A-7 of the Phase 2 GDM, the design velocity through the bridge is 7.3 fps. From the high turbulence curve of HDC 712-1, a riprap minimum W50 of 27 pounds is needed. For a turbulent condition, ETL 1110-2-120 recommends a layer thickness of 21 inches to get the required W50. When the required filter thickness was added to the riprap thickness it was determined that the total thickness was too great for the existing bridge footings. Excavating to install the riprap and filter would undermine the footings so much that the bridge might not be stable. It was therefore decided to use 18-inch gabions for the erosion protection and that is what is proposed in this memorandum. However, there are two basic problems with gabions, one is that they are more expensive to install than riprap and the other is that they can deteriorate rapidly. In some cases they need repair after as little as five years. For plans and specifications the gabion/riprap protection for this bridge will be reexamined. It is possible that a riprap and filter with the same thickness as the proposed 18-inch gabions and 9-inch bedding would provide adequate protection and a longer life.

22. Silver Lake Dam. An earlier part of this appendix discusses the proposed changes to this dam in detail.

23. Silver Lake (sta 127+00 to 151+30). The proposed project includes dredging of a channel through Silver Lake. There is sediment deposition in this lake for existing conditions and requires periodic dredging by the city. The proposed dredging is needed to lower the water surface profile. Additional modifications to the Silver Lake dam to lower the headwater further and reduce or eliminate the need for dredging the lake are not cost effective. The proposed lowering of the crest of the dam is about the maximum allowable without replacing the total spillway structure. An HEC-2 analysis of the impacts of not dredging was done and was found to raise the design profile by almost 1.0 foot. Other points of interest in the hydraulic design of this portion of reach 1b are: -The alignment of the proposed channel through the lake has changed in two places from that shown in the Phase 2. The alignment

has been changed to provide a straighter approach to the Silver Lake dam. This required a slight narrowing of the channel just upstream of the dam to eliminate excavation of the right bank of the lake. This slight narrowing was found to have very little impact on the design flood profile. The other change in the alignment was to smooth out the curve (increase the radius) of the proposed channel at about station 149+00. -The starting water surface elevation for the HEC-2 model was based on the rating curve for the Silver Lake dam. The headwater curve for the dam gives the energy grade line elevation. -The minimum freeboard for this area is at cross-section 37, station 138+00. There are some residences on the left side of the lake and across 12TH St NE from the lake that are located on ground at about elevation 981.0. The design profile at this section is 980.1. Several areas where the roadway around the lake would have shallow flooding at the design flood peak. -The projected maintenance dredging requirements were estimated the sediment study done by WES to be 1900 cu yd/yr after the upstream channel had reached a stable condition. The prediction was that the first 5 to 10 years could average 10,300 cu yd/yr as the channel stabilized. The estimated existing average annual dredging is 7300 cu yd. The lowering of the channel in the upper portion of reach 1b from that used in the Phase 2 design, should help the channel to stabilize sooner so the 10,300 cu yd/yr is considered to be on the high side for the estimate for the first 5 to 10 years.

24. Silver Lake to 7TH St Bridge (sta 151+30 to 156+70). This portion of the reach has been widened from a bottom width of 175 feet in the Phase 2 GDM to 225 feet. The new channel width more closely matches the existing opening of the 7TH bridge. There is adequate room for widening of the channel and it was found to result in a lowering of the design flood profile. It was checked if extending the 225-foot channel further downstream (to station 152+50) would lower the flood profile but was found to have very little impact, less than is very low on the river side (below the design flood profile). However, flood damages to the lower level of this building are not believed to be significant.

25. 7TH St Bridge. The existing bridge is wide and high and does not require replacement or raising. A 10-foot wide bike path has been added along the right side of the bridge. This bikepath was modeled and was found to have very little impact on the design flood. The design velocity through the bridge is 8.4 fps. From the high turbulence curve of HDC 712-1 the minimum W50 is 63 pounds.

26. 7TH St Bridge to Power Plant Dam (sta 157+35 to 169+60). This portion has had the bottom lowered and narrowed from that shown in the Phase 2 GDM. The bottom width was narrowed from 230-foot to 215-foot. The alignment and top-of-cut lines are basically the same as the Phase 2 design. The banks are to be riprapped since the design velocity is about 7 to 9 fps. The proposed design includes flow in the right side overbank. As seen in the attached HEC-2 printout, for cross-sections 43 to 45.5 the amount of right overbank flow is less than 400 cfs, which is less than 2% of the total flow. This right overbank area has been encroached somewhat by the proposed bikepath and fill for the sanitary sewer but the impact on the design profile was found to be insignificant. The road that follows the left bank (2ND Ave NE) has a low point of 981.8 at about channel station 166+00. The design flood elevation at this point is 981.8. However, the low ground around the power plant buildings across the street from the river is at about elevation 984.0 and this elevation is considered to be the start of significant damage. The existing channel bottom at the upper end of this portion is bedrock. Removal of up to

about 4 feet of the bedrock is proposed. It is felt by the Corps geologist that this amount of bedrock can probably be removed by mechanical means, probably ripping. Removal of this bedrock and of the power plant dam is considered a very important part of the flood control project.

27. Power Plant Dam (sta 169+60). The existing dam is used to direct flows to the power plant inlet. Directing the river flows past the inlet helps to sweep debris from the inlet. The proposed channel design includes lowering the channel bottom about 4.0 feet, to elevation 968.3. The channel bottom at this location is bedrock. The existing dam is at about elevation 977.5 and was found to be a serious impediment to flood flows. The proposed design calls for removal of the existing dam and no replacement. A short, 2 to 3-foot high dam that would be used to direct low flows past the inlet was examined, however, the utility company has said that a replacement dam is not needed.

28. Power Plant Dam to Dakota, Minnesota and Eastern RR Bridge (sta 169+60 to 174+15) This portion of the proposed design includes a wall on the right bank to minimize encroachment into the cemetery. The wall will also provide a more pleasing view from the opposite side of the river. The wall is generally to sit on the existing bedrock which is to be cut to a 1V:2H slope. The width of the proposed channel in this area is restricted by the cemetery on the right bank and by the roadway on the left bank. The opening of the railroad bridge also limits any increase in width of this portion. The proposed design calls for a 1V:2H rockfill on the left bank. The channel bottom in this segment has bedrock in the lower portion but not in the upper part.

29. Dakota, Minnesota and Eastern RR Bridge (sta 174+15). As can be seen from the plot of channel velocities, Plate A-8, this is a very restrictive bridge. The bridge is high enough but is narrower than the channel upstream and downstream and has a large total width of piers. If this bridge is ever replaced it should be widened and the piers narrowed. The design velocity through the bridge is 14.0 fps for the low friction value HEC-2 run. From the high turbulence curve of HDC 712-1 this would require riprap protection with a W50 of at least 1350 pounds. From ETL 1110-2-120 the required layer thickness with a W50 of at least 1350 pounds and to protect against turbulent flow would be about 6.5 feet thick. Placement of this thick a riprap layer plus bedding or filter could undermine the existing piers and abutments. Therefore, gabion protection is proposed using 18-inch gabions. As discussed in the paragraph on the North Broadway bridge, the expected life of gabions is much less than riprap and for the plans and specifications alternatives to the proposed gabions should be reevaluated. The required thickness of the gabion layer will also be reevaluated since in general the required gabion thickness is 1/3 to 1/2 of the computed riprap thickness, indicating the need for a gabion thickness of about 3 feet.

30. D, M & E RR to Center Street Bridge (sta 174+15 to 184+80). The proposed design for this portion of reach 1b is 145-foot bottom width channel with a vertical wall on the left bank and a 1V:2.5H riprap slope on the right bank. The Phase 2 GDM design had vertical walls on both sides but it was found that having one side sloped would save money and still provide the required protection. The lowering of the bottom has helped to allow the sloped side. The sloped side is used on the right because the toe of the right side is in bedrock and construction of a wall would be difficult. The present design allows saving the large City building on the right bank. The top of the wall along the left bank from about station 175+00 to 182+00 is to be slightly above the ground elevation to provide 3.0 feet of freeboard. Damage elevation

in the area of the freeboard wall is above the design water surface by the design freeboard level, 2.0 feet, but the natural ground level along the river is lower and the raised wall will keep the design flow completely in the channel.

31. Center Street Bridge (sta 184+80). The existing bridge is large and high enough and the only thing proposed is erosion protection. A bikepath has been added to go under the bridge on the right side. This bikepath was found to have no significant impact on the design flood elevations. The design flood velocity for low friction is 9.3 fps. From HDC 712-1, high turbulence, a minimum W50 of 116 pounds is needed. From ETL 1110-2-120 a 33 to 36 layer thickness is needed for this min W50. Eighteen-inch gabions are proposed in place of the riprap.

32. Center St to Bear Creek (sta 184+80 to 194+65). The proposed design in this area calls for a 130-foot bottom width channel with a 1V:3H riprapped right side and a 1V:2H rock fill right side. The rock fill is proposed for the right side since this bank calls for fill and using a steeper slope reduces the encroachment in the channel and thus reduces the amount of excavation required on the other bank. An analysis by the geotechnical engineers near the end of the study for this report found that the rockfill section will probably not be stable due to bedrock which is near the surface at the toe of the slope. A hydraulic analysis was done to determine what bottom would be needed if this slope were flattened to 1V:2.5H. It was found that the bottom width could be narrowed from 130 feet to 125 feet if the left bank is left at 1V:3H and the right bank changed to 1V:2.5H. It is likely that the plans for this area will reflect the change in the right bank slope. The design, low friction, velocity in this area is fairly high, about 9 fps, and there is a sharp bend to the left. Thus, the required riprap size on the right bank is fairly large. The left bank area is a park and some of the land is at about the design flood elevation, however, there is no significant overbank flow in this area. Filling of the left bank area would have no significant impact on the design flood profile.

33. Confluence with Bear Creek (sta 194+65). The hydrology analysis for the Phase 2 GDM found that the Zumbro River upstream of Bear Creek and Bear Creek do not peak at the same time. The Zumbro design discharge downstream of Bear Creek is 21500 cfs and upstream it is 16800 cfs. The Bear Creek design discharge is 9700 cfs. The alignment for the proposed channel for the downstream end of Bear Creek has been changed somewhat from that shown in the Phase 2 GDM. The currently proposed alignment more closely follows the existing channel alignment. The new alignment will be less costly to construct and it is felt that the hydraulic performance will be improved. The Phase 2 alignment called for a straight channel and would likely have been a high maintenance area as a point bar would have formed. The proposed protection under the Fourth Street bridge over Bear Creek is the same as was proposed in the Phase 2. The protection under this bridge will be reevaluated in the Bear Creek FDM.

34. Bear Creek to Third Ave Bridge (sta 194+65 to 205+66). The proposed channel in this area has a 120-foot bottom width and 1V:3H riprapped side slopes. The upstream end of this portion, the Third Ave bridge, is the upstream end of reach 1b. The design discharge above Bear Creek drops significantly from 21500 to 16800 cfs, this results in design velocities being significantly lower than just downstream of Bear Creek. The low friction design velocity in this area is about 7 fps. The right bank in this area is

one of the low freeboard problem areas. The low ground elevation at the County Health Center on the left bank of Bear Creek just downstream of Fourth Street and at a building on Third Ave S.E. at the corner with Third St S.E., are both at about elevation 987. The design water surface in this area is also at about 987. Both of these buildings are at least 100 feet from the Zumbro River channel bank. The Phase 2 GDM proposed replacing the existing Third Ave bridge (called Second Ave bridge in the Phase 2 GDM) because the low chord is much too low, however, the city is presently considering replacing this bridge for other reasons. The plans presented to date (31 Dec 86) include raising the low chord to 989.1 which is 1.5 feet above the design flood headwater elevation. This is considered an acceptable design for the flood control project. The final design for this bridge should be included in the FDM for the next reach, 2a.

35. SENSITIVITY ANALYSIS As has been mentioned in previous paragraphs, the HEC-2 model for reach 1b was also run with low friction factors. The Mannings "n" values used for the design and for the low friction runs were the same as used in the Phase 2 GDM, .035 for the channel for design and .025 for low friction. The channel velocities obtained from the low friction run are shown on Plate A-8. The highest is through the D, M & E railroad bridge and is 14.0 fps. The Froude number for this velocity in the bridge is 0.74. The velocities obtained from the low friction model were used to design the erosion protection for the channel and the bridges.

36. EROSION PROTECTION

The proposed channel bank riprap was sized using the shear stress method proposed in EM 1110-2-1601 and ETL 1110-2-120. Riprap at bends was sized taking into account the increase in shear stresses at bends as shown on Plates 33 and 34 of EM 1110-2-1601. The required minimum layer thickness and gradation for the riprap was computed for several different locations but for reasons of economy some of the gradations that were very similar were combined and in some areas a larger riprap than the minimum was used to reduce the number of different gradations. Also, for some of the areas the riprap size computed by the shear stress and alpha method were considered too small for the design velocity and the proposed size was increased. For example, the shear stress method said that the minimum riprap size, a 12-inch layer with a minimum W50 of 17 pounds, was adequate for section 50, station 179+00, where the design velocity is 10 fps. Based on the District's experience with erosion protection for flows with this velocity, this was not considered reasonable and the proposed riprap size was increased. It was also increased since the small riprap sizes are considered more susceptible to vandalism, especially in urban areas. The minimum 12-inch layer is only proposed where the design velocity (low friction) is less than 9 fps and there are no sharp bends. Table A-5 is a summary of the computed minimum riprap sizes and the recommended minimum sizes.

TABLE A-5
SUMMARY OF MINIMUM RIPRAP SIZES

SECTION	STATION	VELOCITY	RADIUS	MINIMUM RIPRAP W50 (LAYER THICKNESS) BY SHEAR STRESS	FINAL RECOMMENDED
50	179+00	10.0	Straight	17 lbs (12")	58 lbs (18")
52.5	188+25	9.1	°1000 ft	17 lbs (12")	58 lbs (18")
53(outside)	190+70	9.1	300 ft	58 lbs (18")	138 lbs (fill)
53.8(outside)	194+45	8.6	200 ft	58 lbs (18")	138 lbs (24")
55(outside)	198+65	6.9	200 ft	17 lbs (12")	58 lbs (18")

The riprap gradations are from Encl 1 of ETL 1110-2-120 for a stone with a unit weight of 165 pounds per cubic foot.

37. Erosion protection at the bridges was sized using the low friction velocity and the high turbulence curve of HDC 712-1. For some of the bridges the required riprap plus filter or bedding was so thick that it was felt that placing the protection would undermine the footings of the bridge and their stability would be questionable. In those cases a thinner gabion protection is proposed. The proposed thickness of the gabions is 1/2 to 1/3 of the required riprap thickness. The recommended riprap size is given for each of the bridges in the discussion of each bridge.

38. CARE OF WATER

Care of water has to do with how flow in the river is handled during the construction period. There are two concerns that the care of water plan has to cover: protection of the construction activity from flood flows and insuring that the temporary measures used for the care of water do not create the potential for significant damages to areas outside the construction area. It is the Corps policy that the Government should assume the risk for damages to the construction activity, this is done to reduce the bids of contractors. The care of water plan therefore will normally give the contractor a minimum top of cofferdam elevation. If the contractor builds the cofferdam to at least that height then if it overtops the government will assume the damages. If the contractor elects not to build to that elevation then he assumes any flood damages. The rule-of-thumb that the St. Paul District uses is to set the top of cofferdam 1 to 2 feet above the cofferdam design flood. The cofferdam design flood generally is set as that flood which has a 5-10% chance of being exceeded during the construction period. The amount of freeboard depends on the material used, 1-foot for sheet pile and 2-foot for earth. The frequency of the design flood depends on the damages that would be sustained if the cofferdam overtopped, a less frequent chance of overtopping is allowed for greater damages areas. The impact of the cofferdams on flood stages outside the construction area are computed and if the stages for floods that can occur during the construction period are significantly raised then the cofferdam scheme is re-examined. Care of water schemes other than cofferdams are designed using the same logic as the cofferdam design. The Hydrology Section developed monthly frequency curves to use in the design. They are shown on Plates A-9 to 12. These curves are based on the historic records at the USGS gage that is downstream of the city. To adjust the flows to make them

appropriate for reach 1b the values on them are multiplied by 0.9. This ratio was obtained by comparing the all year frequency curves on Plates D-16 and 17 of the Phase 2 GDM. Since these curves are based on historical records, the use of them has the implicit assumption that this reach will be built prior to the SCS reservoirs becoming effective.

39. Silver Lake Dam. The proposed construction sequence is to cofferdam the tainter gate area first and do the modifications to them. Then the spillway area will be cofferdammed and the hinged leaf gate installed. The present plan calls for the tainter gate cofferdams to be in from the middle of September to the end of November. The spillway cofferdam would be in from the start of December to the middle of February. If this schedule is maintained then the recommended cofferdam design discharges are 2350 to 4500 cfs for the tainter gate cofferdams and 1350 to 2700 cfs for the spillway cofferdams. The development of these design discharges is shown in Table A-6. The corresponding water surface elevations for these discharges are 976.9 to 978.5 for the tainter gate cofferdams and 970 to 971.4 for the spillway cofferdam. The tainter gate cofferdam elevations were computed using the weir equation for flow over the existing spillway with a width of 140 feet and a weir coefficient of 3.5. The spillway cofferdam elevations are from the curve on Plate A-4 for all 3 tainter gates full open. To get the top of cofferdam elevations, freeboard must be added to the above water surface elevations. Thus, depending on the type of material used and the damages that could be sustained if the cofferdam overtopped, the minimum tainter gate cofferdam elevation (upstream) should be from 978.2 to 981.1 and the spillway cofferdam (upstream) from 971 to 973.2. The final cofferdam elevations will be determined for the plans and specs, the method used will be as detailed here. As long as the construction is done as scheduled, the potential impacts on upstream areas is considered acceptable. When the tainter gate cofferdams are in, all flow must pass over the existing spillway. A total flow of about 7000 cfs can go over the spillway without exceeding a headwater of 980.0, this is the project design headwater. When the spillway cofferdams are in, the tainter gates can pass about 5000 cfs without exceeding a headwater of 980.0. At the USGS gage the 5000 cfs discharge for reach 1b would be 5600 cfs and the 7000 cfs discharge at reach 1b corresponds to 7800 cfs at the gage. The probability of exceeding a headwater elevation of 980.0 during the construction period is is about 6%, as shown in Table A-7. This is considered a reasonable value, especially since there is no significant flood damage at 980.0 and there is no sudden jump in damages if the headwater should slightly exceed 980.0.

TABLE A-6
RECOMMENDED DISCHARGES FOR SILVER LAKE DAM COFFERDAM

Month	Exceedence Probability at This Discharge (at USGS Gage) 1500	2600	3000	5000	
Sept	.13	2.75	.065	.038	
Oct	.08	.043	.036	.021	
Nov	.042	.022	.019	.010	
Dec	.035	.017	.015	—	
Jan	.042	.027	.022	—	
Feb	.052	.032	.028	—	
Prob:					
(Sep-Nov)	.18	.099	.085	.049	Use 2600 to 5000 cfs.
(Dec-Feb)	.100	.059	.050	—	Use 1500 to 3000 cfs.

NOTE: Probability of Sep-Nov is the probability of the river exceeding that discharge during the period when the tainter gate cofferdam is in. That is from the middle of Sep to the end of Nov. The equation used to compute the value is:

P(Sep-Nov) = 1 - [(1-.5*P(Sep))*(1-P(Oct))*(1-.5*P(Nov))]

The probability for Dec-Feb was computed in the same manner. The discharges in the table have to be multiplied by .9 to get the discharge for reach 1b.

TABLE A-7
IMPACT OF SILVER LAKE COFFERDAMS

Month	Chance of Reaching Headwater of 980.0 Tainter Gate Cofferdam(Q=7800)	Spillway Cofferdam(Q=5600)
Sept	2.2%	N/A
Oct	1.3%	N/A
Nov	0.6%	N/A
Dec	N/A	0.75%
Jan	N/A	1.3%
Feb	N/A	1.6%

Total Prob = 1 - [(1-.5*.022)*(1-.013)*(1-.006)*(1-.0075)*(1-.013)*(1-.5*.016)]
= .057 = 5.7%

40. Channel. The proposed care of water plan for the channel work does not include the use of any major cofferdams. The proposed plan is to excavate a temporary channel along the left side of the existing channel first and then to do the work on the right bank side in the dry when the river is low and in the wet if the river is high. The proposed plan should not raise flood levels for areas outside the construction area.

41. CHANNEL MAINTENANCE

Based on past experience in widening and deepening channels, bed aggradation might be expected, resulting in a need to periodically dredge the channel to maintain the integrity of the project. However, the WES sediment analysis shows that no bed aggradation would occur except in Silver Lake, which is presently dredged by the city anyway. As a result, no additional bed aggradation should occur as a result of the project. As a precautionary measure, a cross section at station 195+00, located just downstream of the confluence with Bear Creek, should be set up to monitor possible aggradation of the channel. Since the bed of the channel at this location has been lowered by about four feet (in accordance with the recommendation of the WES report), and because of the nearby sediment input from Bear Creek, this area would have the greatest potential to not behave as predicted by the HEC-6 model. This section should be surveyed once every five years and if the average bed elevation rises more than 2 feet above the design elevation, the channel should be dredged back to this design elevation. Another monitoring station should be set up at station 150+00, which is located in Silver Lake approximately 200 feet downstream of the location where the South Fork of the Zumbro River widens to form Silver Lake. This section should also be monitored once every 5 years, and if the channel rises by more than 2 feet

above the design elevation, the channel should be dredged back to this design elevation. The amount of dredging required in the lake should decrease sharply after the project is built because the average annual amount of sediment deposited in Silver Lake, according to the WES report, will decrease from the current rate of 7300 cubic yards to 1900 cubic yards after the project is built.

42. Another possible result of widening and deepening the channel would be the formation of sediment bars on alternate banks within the channel. If left to grow, these bars can have the effect of raising the potential water surface profile of a flood by lengthening and constricting the channel, and can increase the angle of attack of the flow on the bank opposite the bar, increasing the potential for erosion of that bank. Setting up stations to monitor these bars is not as simple as monitoring the bed for general aggradation because the location of alternate bars is difficult to predict and because the bars can remain submerged even under low flow conditions. A visual reconnaissance of the entire reach should be made five years after construction to determine if any bars are present. If no alternate bars can be found, Silver Lake should be drained to determine if any undetected bars are present. The two foot criteria should be used when determining if dredging is necessary.

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PPPPP          M   M          FFFFFF   OOOO   L       EEEEEE  Y   Y
P   P          MM MM          F       O    O  L       E        Y Y
P   P          M MM M         F       O    O  L       E         YY
PPPPP    ..    M    M   ..    FFFF    O    O  L       EEEE      Y
P        ..    M    M   ..    F       O    O  L       E        Y
P              M    M         F        OOOO   LLLLLL  EEEEEE  Y
```

ST PAUL DIST ARMY CORPS H-500   PRINTER: 6

P. M. FOLEY   19 DEC 86 14:03:43

JOB: HEC2B

FILE: 1020FE *PMFOUT

REACH 1B
HIGH N
DESIGN FLOOD

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*****************************************************
*  WATER SURFACE PROFILES                           *
*  VERSION OF NOVEMBER 1976                         *
*  UPDATED MAY 1984                                 *
*                                                   *
*  RUN DATE  19 DEC 86 TIME   14:01:53              *
*****************************************************
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**************************************
*  U.S. ARMY CORPS OF ENGINEERS      *
*  THE HYDROLOGIC ENGINEERING CENTER *
*  609 SECOND STREET, SUITE D        *
*  DAVIS, CALIFORNIA 95616           *
*  (916) 440-2105 (FTS) 448-2105     *
**************************************
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X     X  XXXXXXX   XXXXX              XXXXX
X     X  X        X     X            X     X
X     X  X        X                        X
XXXXXXX  XXXX     X         XXXXX     XXXXX
X     X  X        X                  X
X     X  X        X     X            X
X     X  XXXXXXX   XXXXX             XXXXXXX
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THIS RUN EXECUTED 19 DEC 86 14:01:54

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**************************************************
HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56
**************************************************
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C
T1 ROCHESTER REACH 1B DAM TO 2ND AVE; CHANNEL N=0.035, 15 AUG 86 PAT FOLEY
T2 THIS IS THE FINAL DESIGN FOR THE JAN 87 REACH 1B FDM
T3 DESIGN FLOOD Q=22000 CFS AT SILVER LAKE DAM FN=ZU4100A

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	7.	0.	0.	0.000000	0.00	0.0	0.	979.300	0.000

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	-1.000	0.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

NC	0.070	0.070	0.035	0.100	0.300	0.000	0.000	0.000	0.000	0.000
QT	1.000	0.000	0.000	0.000	0.000	0.000	22000.000	0.000	0.000	0.000
ET	0.000	9.100	9.100	9.100	9.100	9.100	9.100	0.000	9894.000	10155.000

CROSS-SECTION	STATION	BOTTOM ELEVATION	BOTTOM WIDTH	LEFT SLOPE	RIGHT SLOPE
35	127+00	962.8	175'	1:3	1:3
35.5	129+50	963.1	155'	1:3	1:3
36	131+50	963.5	175'	1:3	1:3
37	138+00	964.5	175'	1:3	1:3
38	142+00	965.1	175'	1:3	1:3
39	147+00	965.9	175'	1:3	1:3
40	151+30	966.5	175'	1:3	1:3
40.1	152+40	966.5	200'	1:3	1:3
40.5	153+50	966.9	225'	1:3	1:3
41	155+50	967.1	215'	1:3	1:2.5
42	156+25	967.1	215'	1:3	VERT
42.1	156+70	967.2	215'	VERT	VERT
7TH ST BRIDGE					
42.2	157+35	967.2	215'	VERT	VERT
43	158+50	967.3	215'	1:3	1:3
SILVER CREEK					
44	162+00	967.6	215'	1:3	1:3
45	166+00	967.9	215'	1:3	1:3
45.5	168+40	968.1	170'	1:3	1:3
46	169+60	968.2	168'	1:2	VERT
47.5	171+35	968.3	160'	VERT	VERT

48	172+50	968.4	155'	1:2	VERT
48.1	174+05	968.6	151'	VERT	VERT
RAILROAD BRIDGE					
48.2	174+40	968.6	151'	VERT	VERT
49	175+60	968.7	145'	VERT	1:2.5
49.1	176+20	968.7	145'	VERT	1:2.5
50	179+00	969.1	145'	VERT	1:2.5
51	180+10	969.2	145'	VERT	1:2.5
51.01	181+80	969.3	145'	VERT	1:2.5
51.05	182+50	969.3	145'	VERT	1:2.5
51.1	184+45	969.3	170'	VERT	VERT
~~CENTER ST BRIDGE~~					
51.2	184+46	969.4	170'	VERT	VERT
CENTER ST BRIDGE					
51.3	185+14	969.4	170'	VERT	VERT
51.4	185+15	969.4	170'	VERT	VERT
52	186+20	969.6	170'	1:3	VERT
52.5	188+25	969.7	130'	1:3	1:2
53	190+70	969.9	130'	1:3	1:2
53.5	193+00	970.1	130'	1:3	1:2
53.8	194+45	970.3	130'	1:3	1:3
BEAR CREEK					
55	198+65	970.6	120'	1:3	1:3
55.5	202+45	970.9	120'	1:3	1:3
56	203+45	971.0	120'	1:3	1:3
56.1	205+30	971.1	149'	VERT	VERT
3RD AVE BRIDGE					

25' U/S OF N. BROADWAY DAM

X1	35.000	30.000	9894.000	10155.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	984.000	9035.000	982.000	9055.000	980.000	9070.000	978.000	9100.000	978.000	9135.000
GR	980.000	9185.000	982.000	9220.000	982.000	9270.000	980.000	9340.000	980.000	9465.000
GR	981.700	9595.000	982.700	9620.000	983.700	9745.000	984.400	9820.000	983.100	9868.000
GR	985.900	9872.000	984.700	9894.000	968.900	9894.000	962.800	9913.000	962.800	10088.000
GR	980.300	10140.000	983.700	10155.000	984.000	10245.000	984.000	10545.000	982.000	10695.000
GR	992.000	10895.000	984.000	10925.000	986.000	10955.000	988.000	11050.000	1004.000	11085.000

THIS CS ADDED 15 AUG 86 BY PMF TO MODEL A NARROW AREA
STATION 129+50

X1	35.500	8.000	9742.000	10114.000	190.000	275.000	250.000	0.000	0.000	0.000
GR	981.000	9702.000	974.000	9742.000	972.000	9752.000	972.000	9896.000	963.100	9923.000
GR	983.100	10078.000	975.000	10114.000	983.000	10137.000	0.000	0.000	0.000	0.000

STATION 131+50 IN SILVER LAKE

X1	36.000	33.000	9640.000	10240.000	305.000	165.000	200.000	0.000	0.000	0.000
X2	0.000	986.760	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	988.000	8065.000	984.000	8375.000	984.000	8435.000	982.000	8480.000	982.000	9550.000
GR	991.500	9565.000	981.500	9640.000	972.300	9701.000	972.100	9821.000	971.000	9881.000
GR	953.500	9903.000	963.500	10078.000	970.800	10100.000	971.500	10121.000	972.500	10131.000
GR	977.300	10144.000	978.400	10156.000	986.400	10173.000	993.900	10240.000	994.300	10279.000
GR	994.000	10330.000	990.000	10520.000	988.000	10635.000	988.000	10735.000	990.000	10855.000
GR	988.000	10920.000	988.000	10975.000	990.000	10995.000	992.000	11035.000	994.000	11090.000
GR	996.000	11115.000	1002.000	11155.000	1004.000	11190.000	0.000	0.000	0.000	0.000

STATION 138+00 IN SILVER LAKE

X1	57.000	32.000	9835.000	10280.000	260.000	650.000	650.000	0.000	0.000	0.000
GR	986.300	7580.000	984.000	7780.000	984.000	8280.000	986.000	8580.000	986.000	8680.000
GR	984.000	8890.000	984.000	9150.000	984.000	9250.000	982.000	9580.000	980.000	9680.000
GR	978.500	9780.000	978.200	9818.000	979.000	9835.000	978.700	9846.000	972.000	9890.000
GR	964.500	9913.000	964.500	10088.000	967.700	10097.000	973.000	10157.000	976.300	10159.000
GR	987.700	10207.000	995.700	10280.000	994.000	10290.000	992.000	10405.000	991.000	10480.000
GR	992.500	10590.000	991.000	10780.000	992.000	10930.000	992.000	11080.000	994.000	11365.000
GR	998.000	11400.000	1006.000	11453.000	0.000	0.000	0.000	0.000	0.000	0.000

STATION 142+00 IN SILVER LAKE

X1	58.000	42.000	9450.000	10457.000	335.000	910.000	400.000	0.000	0.000	0.000
GR	986.390	7150.000	986.000	7220.000	984.000	7255.000	981.000	7375.000	984.000	7670.000
GR	988.000	7740.000	986.000	7850.000	986.000	7960.000	988.000	8000.000	990.600	8140.000
GR	990.000	8220.000	987.500	8475.000	988.000	8700.000	986.000	8730.000	984.000	8870.000
GR	982.390	9450.000	981.700	9475.000	981.400	9504.000	978.200	9575.000	970.700	9650.000
GR	970.130	9700.000	971.100	9730.000	971.700	9810.000	969.100	9901.000	965.100	9913.000
GR	965.100	10088.000	966.300	10092.000	966.500	10140.000	970.900	10200.000	973.500	10320.000
GR	977.500	10331.000	979.000	10375.000	987.500	10457.000	987.000	10472.000	990.000	10490.000
GR	992.000	10510.000	994.000	10690.000	994.000	10910.000	996.000	10990.000	998.000	11190.000
GR	1000.000	11325.000	1002.000	11385.000	0.000	0.000	0.000	0.000	0.000	0.000

STATION 147+00 IN SILVER LAKE

X1	59.000	52.000	9320.000	10760.000	320.000	380.000	500.000	0.000	0.000	0.000
GR	987.000	6755.000	988.000	6835.000	986.000	6860.000	984.000	6955.000	984.000	7210.000
GR	986.000	7255.000	986.000	7390.000	988.000	7400.000	989.100	7520.000	998.300	7760.000
GR	990.000	8025.000	990.000	8115.000	989.000	8170.000	991.000	8290.000	988.000	8420.000
GR	986.000	8470.000	984.000	8530.000	966.000	9120.000	984.000	9230.000	982.000	9305.000
GR	981.000	9320.000	975.000	9572.000	966.500	9702.000	966.200	9772.000	968.700	9832.000
GR	968.400	9852.000	965.300	9892.000	965.900	9904.000	965.900	9913.000	965.900	10088.000
GR	967.200	10092.000	969.700	10142.000	964.800	10225.000	968.700	10230.000	972.000	10342.000
GR	971.600	10462.000	967.700	10532.000	968.200	10582.000	971.800	10602.000	972.700	10630.000
GR	980.000	10760.000	990.000	10790.000	992.000	10800.000	994.000	10860.000	994.000	10990.000
GR	992.400	11040.000	993.600	11350.000	994.000	11480.000	996.000	11640.000	998.000	11700.000
GR	1000.000	11770.000	1002.000	11830.000	0.000	0.000	0.000	0.000	0.000	0.000

STATION 151+30 IN SILVER LAKE, RIGHT SIDE OF LAKE NON-EFF. FLOW AREA

X1	40.000	43.000	9517.000	9984.000	175.000	535.000	430.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	986.000	0.000
GR	990.000	6527.000	990.000	6677.000	988.000	6687.000	986.000	6732.000	986.000	6987.000
GR	988.000	7072.000	990.000	7842.000	990.000	8142.000	988.000	8317.000	986.000	8407.000
GR	990.000	8507.000	986.000	8797.000	986.000	8957.000	984.000	9127.000	982.000	9157.000
GR	971.400	9167.000	976.500	9317.000	975.100	9517.000	971.900	9554.000	969.800	9594.000
GR	969.800	9602.000	966.500	9612.000	966.500	9959.000	970.000	9974.000	970.300	9984.000
GR	969.700	10014.000	967.400	10044.000	966.900	10074.000	967.300	10134.000	970.000	10174.000
GR	970.400	10304.000	976.700	10367.000	975.300	10417.000	976.400	10592.000	981.300	10692.000
GR	981.300	10704.000	990.000	10752.000	992.000	10777.000	994.000	10852.000	996.000	11032.000
GR	998.000	11392.000	1000.000	11407.000	1001.000	11467.000	0.000	0.000	0.000	0.000

	THIS CS ADDED 15 AUG 86 BY PMF TO MODEL A NARROW AREA									
	STATION 152+40									
X1	40.100	22.000	9550.000	9850.000	40.000	200.000	110.000	0.000	0.000	0.000
GR	990.000	6527.000	990.000	6677.000	988.000	6687.000	986.000	6732.000	986.000	6987.000
GR	958.000	7072.000	990.000	7842.000	990.000	8142.000	988.000	8317.000	986.000	8407.000
GR	984.000	8507.000	986.000	8797.000	986.000	8957.000	984.000	9127.000	982.000	9157.000
GR	981.400	9167.000	976.500	9317.000	975.100	9517.000	976.000	9550.000	966.500	9579.000
GR	966.500	9779.000	990.000	9850.000	0.000	0.000	0.000	0.000	0.000	0.000
	STATION 153+50 ENTRANCE TO SILVER LAKE									
X1	40.500	35.000	9861.000	10170.000	40.000	130.000	110.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	986.000	0.000
GR	992.600	6835.000	992.000	6880.000	991.500	6960.000	992.000	7110.000	990.000	7190.000
GR	989.000	7360.000	990.000	7560.000	992.000	7810.000	990.000	8725.000	988.000	8770.000
GR	986.000	8810.000	984.000	8855.000	984.000	8900.000	986.000	9185.000	986.000	9310.000
GR	984.000	9490.000	981.800	9510.000	979.400	9560.000	976.300	9735.000	975.900	9861.000
GR	966.900	9888.000	966.900	10113.000	986.000	10170.000	985.900	10185.000	984.600	10210.000
GR	984.100	10285.000	988.600	10740.000	982.000	10825.000	980.000	11090.000	980.000	11410.000
GR	986.000	11650.000	988.000	12000.000	990.000	12060.000	994.000	12085.000	994.500	12120.000
ET	0.000	9.100	9.100	9.100	9.100	9.100	9.100	0.000	9795.000	10171.000
	STATION 155+50 D/S END OF CONTRACTION, D/S 7TH ST. NE BRIDGE									
	RIGHT BANK BIKEPATH AT EL 980 ADDED 16 AUG 86									
X1	41.000	26.000	9859.000	10163.000	50.000	120.000	200.000	0.000	0.000	0.000
GR	992.600	6835.000	992.000	6880.000	991.500	6960.000	992.000	7110.000	990.000	7190.000
GR	989.000	7360.000	990.000	7560.000	992.000	7810.000	990.000	8725.000	988.000	8770.000
GR	986.000	8810.000	984.000	8855.000	984.000	8900.000	986.000	9185.000	986.000	9310.000
GR	984.000	9490.000	981.800	9510.000	979.400	9560.000	976.300	9735.000	976.400	9795.000
GR	976.500	9859.000	967.100	9888.000	967.100	10103.000	980.000	10135.000	980.000	10145.000
GR	986.000	10163.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	9.100	9.100	9.100	9.100	9.100	9.100	0.000	9814.000	10168.000
	STATION 156+25 U/S END OF CONTRACTION, D/S 7TH ST NE									
	RIGHT BANK BIKEPATH ADDED AT EL 983 (INCLUDES RAILING) 15 AUG 86									
	LB FILL TO EL 976 ADDED 16 AUG 86 BY PMF									
X1	42.000	28.000	9861.000	10113.100	150.000	100.000	75.000	0.000	0.000	0.000
X2	0.000	987.330	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	995.500	6740.000	994.000	6780.000	990.000	6890.000	992.000	6910.000	992.000	7240.000
GR	994.000	7640.000	998.000	7660.000	998.000	7755.000	992.000	7810.000	990.000	7830.000
GR	990.000	8470.000	988.000	8510.000	986.000	8705.000	986.000	9345.000	986.000	9480.000
GR	985.300	9530.000	986.000	9560.000	985.300	9630.000	979.600	9705.000	979.100	9755.000
GR	976.000	9814.000	976.000	9857.000	976.000	9861.000	967.100	9888.000	967.100	10103.000
GR	980.000	10103.100	980.000	10113.000	986.000	10113.100	0.000	0.000	0.000	0.000
NC	0.000	0.000	0.000	0.300	0.500	0.000	0.000	0.000	0.000	0.000
	7TH ST. NE BRIDGE									
	RIGHT BANK BIKEPATH INCLUDED 15 AUG 86									
X1	42.100	67.000	9880.000	10130.000	50.000	50.000	45.000	0.930	0.000	0.000
X2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.930	0.000
BT	-53.000	7130.000	996.000	996.000	7310.000	998.000	998.000	7930.000	998.000	998.000
BT	0.000	8015.000	996.000	996.000	8080.000	994.000	994.000	8205.000	992.000	992.000
BT	0.000	8495.000	990.000	990.000	8780.000	988.000	988.000	8990.000	986.000	986.000
BT	0.000	9570.000	985.700	985.700	9607.000	985.130	985.130	9657.000	985.480	985.480

BT	0.000	9707.000	986.450	986.450	9757.000	987.500	987.500	9807.000	988.400	988.400
BT	0.000	9857.000	989.440	989.440	9880.000	990.000	990.000	9881.000	990.100	985.000
BT	0.000	9891.000	990.200	986.200	9901.000	990.200	987.100	9911.000	990.200	987.400
BT	0.000	9921.000	990.200	987.500	9931.000	990.200	987.100	9941.000	990.200	985.800
BT	0.000	9951.000	990.300	986.600	9961.000	990.300	987.600	9971.000	990.300	987.900
BT	0.000	9981.000	990.400	987.900	9991.000	990.400	987.500	10001.000	990.400	986.700
BT	0.000	10011.000	990.500	987.000	10021.000	990.500	988.000	10031.000	990.500	988.200
BT	0.000	10041.000	990.500	988.100	10051.000	990.500	987.800	10061.000	990.500	986.800
BT	0.000	10067.000	990.500	985.800	10071.000	990.600	986.200	10081.000	990.600	987.400
BT	0.000	10091.000	990.600	988.000	10101.000	990.600	987.900	10109.000	990.600	987.400
BT	0.000	10113.000	990.700	987.400	10129.000	990.700	984.500	10130.000	989.900	989.900
BT	0.000	10180.000	989.500	989.500	10230.000	988.600	988.600	10280.000	987.600	987.600
BT	0.000	10330.000	986.690	986.690	10380.000	986.400	986.400	10430.000	985.200	985.200
BT	0.000	11720.000	986.800	986.800	12310.000	989.900	989.900	0.000	0.000	0.000
GR	996.000	7130.000	998.000	7310.000	998.000	7930.000	996.000	8015.000	994.000	8080.000
GR	992.000	8205.000	990.000	8495.000	988.000	8780.000	986.000	8990.000	985.700	9570.000
GR	985.130	9607.000	985.480	9657.000	986.450	9707.000	987.500	9757.000	988.400	9807.000
GR	989.440	9857.000	990.000	9880.000	967.200	9881.000	967.200	9891.000	967.200	9901.000
GR	967.200	9911.000	967.200	9921.000	967.200	9931.000	967.200	9940.000	967.200	9941.000
GR	985.800	9941.000	985.800	9943.000	967.200	9943.000	967.200	9951.000	967.200	9961.000
GR	967.200	9971.000	967.200	9981.000	967.200	9991.000	967.200	10000.000	967.200	10001.000
GR	986.700	10001.000	986.700	10003.000	967.200	10003.000	967.200	10011.000	967.200	10021.000
GR	967.200	10031.000	967.200	10041.000	967.200	10051.000	967.200	10061.000	967.200	10066.000
GR	967.200	10067.000	985.800	10067.000	985.800	10069.000	967.200	10069.000	967.200	10071.000
GR	967.200	10081.000	967.200	10091.000	967.200	10101.000	967.200	10109.000	967.200	10113.000
GR	967.200	10113.100	980.000	10113.200	980.000	10129.000	989.900	10130.000	989.500	10180.000
GR	988.600	10230.000	987.600	10280.000	986.690	10330.000	986.350	10380.000	985.200	10430.000
GR	986.800	11720.000	989.900	12310.000	0.000	0.000	0.000	0.000	0.000	0.000

NC	0.000	0.000	0.000	0.100	0.300	0.000	0.000	0.000	0.000	0.000

7TH ST NE BRIDGE
RIGHT BANK BIKE PATH INCLUDED 15 AUG 86

X1	42.200	0.000	0.000	0.000	45.000	45.000	65.000	0.000	0.000	0.000
X2	0.000	987.270	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000

STATION 158+50 110' D/S OF SILVER CREEK CONFLUENCE
LB FILL TO EL 983 ADDED 16 AUG 86 BY PDF

X1	43.000	30.000	9846.000	10124.000	100.000	100.000	115.000	0.000	0.000	0.000
GR	1000.000	8090.000	998.000	8125.000	994.000	8145.000	990.000	8255.000	989.500	8460.000
GR	990.500	8705.000	988.000	8780.000	986.000	8880.000	987.100	9160.000	985.700	9380.000
GR	983.000	9730.000	983.000	9755.000	983.000	9830.000	983.000	9846.000	967.300	9893.000
GR	967.300	10108.000	972.500	10124.000	978.000	10146.000	983.900	10205.000	983.300	10255.000
GR	983.600	10405.000	984.000	10480.000	984.000	10980.000	986.000	11030.000	988.000	11065.000
GR	990.000	11105.000	992.000	11160.000	994.000	11190.000	996.000	11210.000	996.300	11230.000

[illegible]	1.000	0.000	0.000	0.000	0.000	0.000	21500.000	0.000	0.000	0.000
ET	0.000	9.100	9.100	9.100	9.100	9.100	9.100	0.000	8035.000	10250.000

STATION 162+00

X1	40.000	30.000	9850.000	10139.000	145.000	650.000	350.000	0.000	0.000	0.000
GR	1002.000	8035.000	1000.000	8055.000	996.000	8065.000	992.000	8150.000	990.000	8305.000
GR	990.000	8735.000	988.000	8835.000	996.000	9035.000	996.000	9285.000	994.000	9340.000
GR	1017.600	9425.000	1000.000	9485.000	990.000	9505.000	988.000	9510.000	986.000	9650.000
GR	984.190	9780.000	982.000	9850.000	967.600	9893.000	967.600	10108.000	977.700	10139.000
GR	[illegible].700	10175.000	976.900	10193.000	982.000	10[illegible].000	982.100	10250.000	981.200	10300.000

GR	979.200	10325.000	979.400	10334.000	982.400	10375.000	983.100	10400.000	1002.400	10464.000

STATION 166+00 D/S END OF EXPANSION
LOW PT IN LB ROAD IS AT THIS CS-981.8
LOW LB BUILDING AT >984 FROM TOPOG
BIKE PATH AND SEWER FILL ADDED TO RB 15 AUG 86

X1	45.000	22.000	9847.000	10135.000	350.000	550.000	400.000	0.000	0.000	0.000
GR	1002.000	8055.000	1000.000	8065.000	998.000	8110.000	996.000	8120.000	994.000	8150.000
GR	992.000	8265.000	990.000	8825.000	990.000	9115.000	988.000	9215.000	990.000	9260.000
GR	1016.000	9350.000	1016.000	9365.000	990.000	9420.000	986.000	9430.000	984.000	9710.000
GR	992.600	9820.000	983.000	9847.000	967.900	9893.000	967.900	10108.000	977.000	10135.000
GR	977.000	10149.000	984.500	10171.000	0.000	0.000	0.000	0.000	0.000	0.000

STATION 168+40 U/S END OF EXPANSION
BIKE PATH AND SEWER FILL ADDED TO RB 15 AUG 86

X1	45.500	17.000	9869.000	10119.000	230.000	170.000	240.000	0.000	0.000	0.000
GR	1002.000	8085.000	1000.000	8095.000	988.000	8110.000	996.000	8175.000	996.000	8295.000
GR	994.000	8325.000	992.000	8725.000	992.000	9200.000	990.000	9215.000	986.000	9545.000
GR	984.100	9836.000	983.800	9869.000	968.100	9916.000	968.100	10086.000	979.000	10119.000
GR	990.000	10138.000	985.000	10153.000	0.000	0.000	0.000	0.000	0.000	0.000

STATION 169+60 D/S OF POWER PLANT DAM (DAM TO BE REMOVED)
VERTICAL WALL ADDED TO RB 15 AUG 86

X1	46.000	27.000	9884.000	10099.100	70.000	160.000	120.000	0.000	0.000	0.000
GR	1002.000	8085.000	1000.000	8095.000	998.000	8110.000	996.000	8175.000	996.000	8295.000
GR	994.000	8325.000	992.000	8725.000	992.000	9200.000	990.000	9215.000	986.000	9545.000
GR	984.100	9836.000	983.800	9884.000	968.200	9915.000	968.200	10083.000	974.500	10099.000
GR	983.000	10099.100	983.000	10163.000	983.000	10189.000	982.800	10275.000	984.000	10425.000
GR	986.000	10455.000	988.000	10470.000	990.000	10500.000	992.000	10515.000	996.000	10560.000
GR	1000.000	10655.000	1002.000	10705.000	0.000	0.000	0.000	0.000	0.000	0.000

STATION 171+35 MIDDLE OF CURVE. VERTICAL WALL ON LEFT.
VERTICAL WALL ADDED TO RB 15 AUG 86

X1	47.500	15.000	9920.000	10105.100	400.000	170.000	175.000	0.000	0.000	0.000
GR	994.400	7982.000	994.000	8837.000	992.000	9002.000	990.000	9027.000	988.000	9342.000
GR	956.000	9920.000	973.300	9921.000	968.300	9931.000	968.300	10091.000	974.000	10105.000
GR	964.000	10105.100	994.000	10390.000	998.000	10550.000	1000.000	10590.000	1004.000	10740.000

STATION 172+50 D/S OF C&NW RR BRIDGE
VERTICAL WALL ADDED TO RB 15 AUG 86

X1	41.000	20.000	9893.000	10082.100	170.000	65.000	115.000	0.000	0.000	0.000
GR	995.700	8160.000	994.000	8725.000	992.000	8700.000	990.000	8915.000	988.000	9090.000
GR	986.000	9130.000	986.000	9345.000	990.000	9510.000	990.000	9765.000	991.700	9865.000
GR	992.000	9893.000	981.200	9894.000	968.400	9920.000	968.400	10075.000	972.000	10082.000
GR	965.000	10082.100	994.000	10380.000	998.000	10540.000	1000.000	10580.000	1004.000	10730.000

NC	0.000	0.000	0.000	0.300	0.500	0.000	0.000	0.000	0.000	0.000
ET	0.000	9.100	9.100	9.100	9.100	9.100	9.100	0.000	9905.000	10075.000

CHICAGO & NORTHWESTERN RAILROAD BRIDGE

X1	48.100	35.000	9914.000	10066.000	425.000	195.000	155.000	0.000	0.000	0.000
GR	1002.000	8040.000	1000.000	8190.000	998.000	8250.000	998.000	8460.000	996.000	8560.000
GR	994.000	8650.000	992.000	8795.000	990.000	9025.000	990.000	9125.000	988.000	9205.000
GR	986.000	9350.000	986.000	9705.000	990.000	9720.000	992.000	9730.000	993.900	9750.000
GR	994.300	9800.000	993.900	9850.000	994.300	9886.000	994.400	9914.000	968.600	9914.100

GR	968.600	10065.900	995.000	10066.000	995.000	10119.000	995.200	10150.000	995.500	10200.000
GR	995.800	10250.000	996.300	10300.000	996.700	10350.000	997.100	10400.000	1000.000	10475.000
GR	1004.000	10635.000	1008.000	10765.000	1010.000	10795.000	1014.000	10840.000	1015.000	10880.000
[illegible]	0.000	9.100	9.100	9.100	9.100	9.100	9.100	0.000	9905.000	10075.000
[illegible]	1.050	1.400	2.500	0.000	152.000	12.400	2500.000	0.000	0.000	0.000

CHICAGO & NORTHWESTERN RAILROAD BRIDGE

X1	44.200	0.000	0.000	0.000	50.000	50.000	35.000	0.000	0.000	0.000
X2	0.000	0.000	1.000	986.400	993.900	0.000	0.000	0.000	0.000	0.000
BT	-53.000	8040.000	1002.000	1002.000	8190.000	1000.000	1000.000	8250.000	998.000	998.000
BT	0.000	8460.000	998.000	998.000	8560.000	996.000	996.000	8650.000	994.000	994.000
BT	0.000	8795.000	992.000	992.000	9025.000	990.000	990.000	9125.000	990.000	990.000
BT	0.000	9205.000	988.000	988.000	9350.000	986.000	986.000	9705.000	986.000	986.000
BT	0.000	9720.000	990.000	990.000	9730.000	992.000	992.000	9750.000	993.900	993.900
BT	0.000	9890.000	994.300	994.300	9850.000	993.900	993.900	9913.000	994.300	994.300
BT	0.000	9910.000	994.800	986.400	10066.000	995.000	986.400	10067.000	995.000	995.000
BT	0.000	10150.000	995.200	995.200	10200.000	995.500	995.500	10250.000	995.800	995.800
BT	0.000	10300.000	996.300	996.300	10350.000	996.700	996.700	10400.000	997.100	997.100
BT	0.000	10475.000	1000.000	1000.000	10635.000	1004.000	1004.000	10765.000	1008.000	1008.000
BT	0.000	10795.000	1010.000	1010.000	10840.000	1014.000	1014.000	10880.000	1015.000	1015.000
NC	0.050	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

STATION 175+60 U/S OF CNW RR BRIDGE
LEFT SIDE VERT, RIGHT SIDE 1:2.5 145 FT BW

X1	49.000	18.000	9900.000	10095.000	250.000	260.000	120.000	0.000	0.000	0.000
GR	1004.000	7947.000	1000.000	8137.000	998.000	8197.000	990.000	9072.000	986.000	9497.000
GR	984.500	9657.000	983.900	9805.000	985.100	9847.000	984.600	9900.000	968.700	9900.100
GR	968.700	10045.000	988.500	10095.000	994.400	10114.000	996.100	10272.000	996.700	10342.000
GR	998.000	10497.000	1000.000	10527.000	1004.000	10682.000	0.000	0.000	0.000	0.000

STATION 176+20

X1	49.100	18.000	9905.000	10103.000	60.000	60.000	60.000	0.000	0.000	0.000
GR	1004.000	7947.000	1000.000	8137.000	998.000	8197.000	990.000	9072.000	986.000	9497.000
GR	984.500	9657.000	983.900	9805.000	985.100	9847.000	984.600	9905.000	968.700	9905.100
GR	968.700	10050.000	989.000	10103.000	994.400	10109.000	996.100	10272.000	996.700	10342.000
GR	998.000	10497.000	1000.000	10527.000	1004.000	10682.000	0.000	0.000	0.000	0.000
NC	0.000	0.000	0.000	0.100	0.300	0.000	0.000	0.000	0.000	0.000

STATION 179+00

X1	50.000	23.000	9908.000	10128.000	180.000	145.000	280.000	0.000	0.000	0.000
GR	1002.000	7748.000	1000.000	7873.000	998.000	8298.000	996.000	8688.000	996.000	8763.000
GR	994.000	8928.000	992.000	9058.000	990.000	9093.000	990.000	9238.000	988.000	9343.000
GR	986.300	9753.000	986.500	9893.000	985.100	9857.000	986.000	9908.000	969.100	9908.100
GR	969.100	10053.000	999.000	10128.000	999.000	10129.000	999.300	10153.000	1000.300	10278.000
GR	1000.000	10803.000	1002.000	11003.000	1004.000	11154.000	0.000	0.000	0.000	0.000

STATION 180+10

X1	51.000	22.000	9895.000	10111.000	130.000	110.000	110.000	0.000	0.000	0.000
GR	1004.000	7197.000	1002.000	7447.000	1000.000	7727.000	998.000	8142.000	996.000	8772.000
GR	994.000	8842.000	992.000	9317.000	990.200	9702.000	990.100	9752.000	991.900	9852.000
GR	991.700	9895.000	969.200	9895.100	969.200	10040.000	997.700	10111.000	997.700	10122.000
GR	999.200	10177.000	1001.600	10194.000	1002.300	10213.000	1002.600	10252.000	1001.600	10277.000
GR	[illegible]	10697.000	1004.000	10772.000	0.000	[illegible]	0.000	0.000	0.000	0.000

STATION 161+80

X1	51.010	17.000	9915.000	10130.000	170.000	170.000	170.000	0.000	0.000	0.000
GR	1000.000	7800.000	998.500	8000.000	997.800	8330.000	997.500	8660.000	994.300	9000.000
GR	992.000	9380.000	990.000	9720.000	990.400	9785.000	991.600	9915.000	991.600	9915.000
GR	969.300	9915.100	969.300	10060.000	997.700	10130.000	997.700	10151.000	997.700	10152.000
GR	999.200	10175.000	1001.800	10200.000	0.000	0.000	0.000	0.000	0.000	0.000

STATION 162+50 D/S OF CENTER ST. BRIDGE

X1	51.050	17.000	9915.000	10130.000	30.000	70.000	70.000	0.000	0.000	0.000
GR	1000.000	7800.000	998.500	8000.000	997.800	8330.000	997.500	8660.000	994.300	9000.000
GR	992.000	9330.000	990.000	9720.000	990.400	9785.000	991.600	9915.000	991.600	9915.000
GR	969.300	9915.100	969.300	10060.000	997.700	10130.000	997.700	10151.000	997.700	10152.000
GR	999.200	10175.000	1001.800	10200.000	0.000	0.000	0.000	0.000	0.000	0.000

NC	0.000	0.000	0.000	0.300	0.500	0.000	0.000	0.000	0.000	0.000

CENTER ST. BRIDGE
BIKE PATH AT 984.5 (INCLUDES RAILING)

X1	51.100	17.000	9914.000	10096.000	120.000	300.000	195.000	0.000	0.000	0.000
GR	1000.000	7800.000	998.500	8000.000	997.800	8330.000	997.500	8660.000	994.300	9000.000
GR	992.000	9280.000	990.000	9720.000	990.300	9770.000	992.700	9914.000	969.300	9915.000
GR	969.300	10085.000	984.500	10085.100	984.500	10095.000	994.800	10096.000	995.700	10170.000
GR	997.600	10280.000	1000.000	10450.000	0.000	0.000	0.000	0.000	0.000	0.000

NC	0.000	0.000	0.000	0.300	0.500	0.000	0.000	0.000	0.000	0.000

CENTER ST. BRIDGE
BIKE PATH AT 984.5

X1	51.200	33.000	9914.000	10096.000	1.000	1.000	1.000	0.000	0.000	0.000
X2	0.000	930.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BT	19.000	7800.000	1000.000	1000.000	8000.000	998.500	998.500	8330.000	997.800	997.800
BT	8660.000	997.500	997.500	9000.000	994.300	994.300	9280.000	992.000	992.000	9720.000
BT	990.000	990.000	9770.000	990.300	990.300	9914.000	992.700	992.700	9915.000	996.800
BT	988.800	9963.000	997.500	989.400	9965.000	997.500	989.400	10035.000	998.300	990.200
BT	10037.000	998.300	990.200	10095.000	998.800	990.900	10096.000	994.800	994.800	10170.000
BT	995.700	995.700	10280.000	997.600	997.600	10450.000	1000.000	1000.000	0.000	0.000
GR	1000.000	7800.000	998.500	8000.000	997.800	8330.000	997.500	8660.000	994.300	9000.000
GR	992.000	9280.000	990.000	9720.000	990.300	9770.000	992.700	9914.000	969.400	9915.000
GR	969.400	9916.000	969.400	9933.000	969.400	9963.000	989.400	9963.000	989.400	9965.000
GR	969.400	9965.000	969.400	10002.000	969.400	10020.000	969.400	10029.000	969.400	10035.000
GR	990.200	10035.000	990.200	10037.000	969.400	10037.000	969.400	10038.000	969.400	10063.000
GR	969.400	10072.000	969.400	10085.000	984.500	10085.000	984.500	10095.000	994.800	10096.000
GR	995.700	10170.000	997.600	10280.000	1000.000	10450.000	0.000	0.000	0.000	0.000

X1	51.300	0.000	0.000	0.000	68.000	68.000	68.000	0.000	0.000	0.000
X2	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000

X1	51.400	17.000	9914.000	10096.000	1.000	1.000	1.000	0.000	0.000	0.000
GR	1000.000	7800.000	998.500	8000.000	997.800	8330.000	997.500	8660.000	994.300	9000.000
GR	992.000	9280.000	990.000	9720.000	990.300	9770.000	992.700	9914.000	969.400	9915.000
GR	969.400	10085.000	984.500	10085.100	984.500	10095.000	994.800	10096.000	995.700	10170.000
GR	997.600	10280.000	1000.000	10450.000	0.000	0.000	0.000	0.000	0.000	0.000

	STATION 186+20 D/S END OF EXPANSION									
	88 BIKE PATH AT 990 (INCLUDES RAILING)									
X1	52.000	24.000	9863.000	10095.100	250.000	10.000	105.000	0.000	0.000	0.000
X2	0.000	992.690	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1004.000	7532.000	1002.000	7597.000	1000.000	7872.000	998.000	8382.000	997.000	8532.000
GR	998.000	8642.000	996.000	8747.000	994.000	9087.000	992.000	9247.000	990.000	9422.000
GR	987.000	9777.000	987.000	9848.000	987.000	9863.000	969.600	9915.000	969.600	10085.000
GR	970.200	10095.000	990.000	10095.100	990.000	10120.000	996.000	10170.000	998.600	10282.000
GR	1000.000	10377.000	1002.000	10457.000	1002.000	10557.000	1004.000	10617.000	0.000	0.000
H	0.000	0.000	0.000	0.100	0.300	0.000	0.000	0.000	0.000	0.000
	STATION 188+25	U/S END OF CONTRACTION								
X1	52.500	13.000	9901.000	10105.000	170.000	140.000	205.000	0.000	0.000	0.000
GR	1000.000	7710.000	998.000	8355.000	996.000	8650.000	994.000	8840.000	992.000	9060.000
GR	990.000	9230.000	988.000	9330.000	986.000	9540.000	983.900	9901.000	969.700	9945.000
GR	969.700	10075.000	985.000	10105.000	1000.000	10170.000	0.000	0.000	0.000	0.000
	STATION 190+70									
X1	53.000	20.000	9886.000	10108.000	115.000	230.000	245.000	0.000	0.000	0.000
GR	1004.000	7550.000	1002.000	7665.000	1000.000	7760.000	998.000	8440.000	996.000	8640.000
GR	996.000	8780.000	994.000	8940.000	990.000	9230.000	986.000	9245.000	986.300	9555.000
GR	986.300	9825.000	986.300	9886.000	969.900	9935.000	969.900	10065.000	991.500	10108.000
GR	999.200	10200.000	1000.200	10225.000	1000.100	10320.000	1002.000	10470.000	1004.000	10700.000
	STATION 193+00	D/S OF BEAR CREEK CONFLUENCE								
X1	53.500	23.000	9810.000	10003.000	235.000	340.000	230.000	0.000	0.000	0.000
GR	1004.000	7515.000	1002.000	7580.000	1000.000	7665.000	1000.000	7865.000	998.000	8435.000
GR	996.000	8605.000	992.000	8825.000	990.000	9035.000	986.000	9325.000	986.000	9505.000
GR	986.000	9640.000	984.000	9810.000	970.100	9852.000	970.100	9982.000	980.700	10003.000
GR	988.000	10050.000	996.000	10120.000	998.000	10190.000	1000.000	10230.000	1002.000	10340.000
GR	1004.000	10400.000	1006.000	10450.000	1008.000	10550.000	0.000	0.000	0.000	0.000
	STATION 194+65									
X1	53.800	23.000	9795.000	10008.000	100.000	100.000	165.000	0.000	0.000	0.000
GR	1004.000	7515.000	1002.000	7580.000	1000.000	7665.000	1000.000	7865.000	998.000	8435.000
GR	996.000	8605.000	992.000	8825.000	990.000	9035.000	986.000	9325.000	986.000	9505.000
GR	986.000	9708.000	984.000	9795.000	970.300	9837.000	970.300	9967.000	984.000	10008.000
GR	988.000	10050.000	996.000	10120.000	998.000	10190.000	1000.000	10230.000	1002.000	10340.000
GR	1004.000	10400.000	1006.000	10450.000	1008.000	10550.000	0.000	0.000	0.000	0.000
JT	1.000	0.000	0.000	0.000	0.000	0.000	16800.000	16800.000	0.000	0.000
ET	0.090	9.100	9.100	9.100	9.100	9.100	9.100	0.000	9889.000	10110.000
	STATION 198+65									
X1	55.000	19.000	9896.000	10103.000	40.000	1030.000	400.000	0.000	0.000	0.000
GR	1004.000	7592.000	1000.000	7747.000	1000.000	7947.000	998.000	8467.000	996.000	8627.000
GR	992.000	8847.000	990.000	9052.000	986.000	9537.000	984.300	9737.000	984.700	9837.000
GR	985.000	9896.000	970.600	9940.000	970.600	10060.000	984.600	10103.000	985.800	10187.000
GR	986.830	10262.000	986.000	10307.000	988.000	10372.000	990.000	10497.000	0.000	0.000

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ET      0.000     9.100     9.100     9.100     9.100     9.100     9.100     0.000  9886.000 10123.000
         STATION 202+45 D/S END OF CONTRACTION AND CHANNEL TRANSITION
X1     55.500    22.000  9894.000 10115.000    20.000   390.000   380.000     0.000     0.000     0.000
GR   1044.000  7970.000  1000.000  8120.000  1000.000  8330.000   968.000  8810.000   996.000  8995.000
GR    994.000  9190.000   992.000  9285.000   990.000  9460.000   988.000  9565.000   986.000  9755.000
GR    985.700  9792.000   985.500  9842.000   986.100  9894.000   970.900  9940.000   970.900 10060.000
GR    969.100 10115.000   988.100 10192.000   967.600 10265.000   988.000 10410.000   990.000 10430.000
GR    992.000 10490.000   994.000 10500.000     0.000     0.000     0.000     0.000     0.000     0.000

ET      0.000     9.100     9.100     9.100     9.100     9.100     9.100     0.000  9917.000 10132.000
         STATION 203+45 U/S END OF CONTRACTION & CHANNEL TRANSITION
         RR BIKE PATH ADDED 16 AUG 86 BY PMF
X1     56.000    25.000  9917.000 10068.100    50.000    50.000   100.000     0.000     0.000     0.000
GR   1004.000  7970.000  1000.000  8120.000  1000.000  8330.000   988.000  8810.000   996.000  8995.000
GR    994.000  9190.000   992.000  9285.000   990.000  9460.000   988.000  9565.000   986.000  9755.000
GR    985.700  9792.000   985.500  9842.000   986.200  9892.000   989.100  9917.000   971.000  9918.000
GR    971.000 10068.000   977.700 10088.000   990.000 10088.100   990.000 10098.000   988.100 10192.000
GR    987.600 10265.000   988.000 10410.000   990.000 10430.000   992.000 10490.000   994.000 10500.000

NC      0.200     0.200     0.035     0.300     0.500     0.000     0.000     0.000     0.000     0.000
ET      0.000     9.100     9.100     9.100     9.100     9.100     9.100     0.000  9903.000 10064.000
X1     56.100    18.000  9903.000 10054.000    20.000   190.000   185.000     0.000     0.000     0.000
GR   1004.000  8475.000  1001.200  8705.000   999.800  9095.000   997.900  9445.000   991.500  9603.000
GR    994.500  9903.000   971.100  9904.000   971.100  9970.000   971.100  9971.000   971.100  9972.000
GR    971.100  9973.000   971.100 10028.000   971.100 10029.000   971.100 10030.000   971.100 10031.000
GR    971.100 10053.000   991.500 10054.000   990.000 11345.000     0.000     0.000     0.000     0.000

ET      0.000     9.100     9.100     9.100     9.100     9.100     9.100     0.000  9903.000 10064.000
         2ND AVE. SF BRIDGE
         RR BIKE PATH ADDED 16 AUG 86 BY PMF
X1     56.200    18.000  9903.000 10054.000     1.000     1.000     1.000     0.000     0.000     0.000
BT     10.000  8475.000  1004.000  1004.000  8705.000  1001.200  1001.200  9095.000   999.800   999.800
BT   9445.000   997.900   997.900  9603.000   991.500   991.500  9903.000   994.500   994.500  9904.000
BT    997.500   990.400 10053.000   997.500   990.400 10054.000   991.500   991.500 11345.000   990.000
BT    990.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
GR   1004.000  8475.000  1001.200  8705.000   999.800  9095.000   997.900  9445.000   991.500  9603.000
GR    994.500  9903.000   971.100  9904.000   971.100  9970.000   990.400  9971.000   990.400  9972.000
GR    971.100  9973.000   971.100 10028.000   990.400 10029.000   990.400 10030.000   971.100 10031.000
GR    971.100 10053.000   991.500 10054.000   990.000 11345.000     0.000     0.000     0.000     0.000

ET      0.000     9.100     9.100     9.100     9.100     9.100     9.100     0.000  9903.000 10064.000
         2ND AVE SF BRIDGE
         RR BIKE PATH ADDED 16 AUG 86 BY PMF
X1     56.300     0.000     0.000     0.000    70.000    70.000    70.000     0.000     0.000     0.000
X2      0.000     0.000     0.000     0.000     0.000     0.000     1.000     0.000     0.000     0.000

ET      0.000     9.100     9.100     9.100     9.100     9.100     9.100     0.000  9903.000 10064.000
X1     56.400    18.000  9903.000 10054.000     1.000     1.000     1.000     0.000     0.000     0.000
GR   1004.000  8475.000  1001.200  8705.000   999.800  9095.000   997.900  9445.000   991.500  9603.000
GR    994.500  9903.000   971.100  9904.000   971.100  9970.000   971.100  9971.000   971.100  9972.000
GR    971.100  9973.000   971.100 10028.000   971.100 10029.000   971.100 10030.000   971.100 10031.000
GR    971.100 10053.000   991.500 10054.000   990.000 11345.000     0.000     0.000     0.000     0.000
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NC	0.000	0.000	0.000	0.100	0.300	0.000	0.000	0.000	0.000	0.000
ET	0.000	9.100	9.100	9.100	9.100	9.100	9.100	0.000	9925.000	10075.000
	STATION 207+75 U/S END OF STUDY									
X1	57.000	27.000	9925.000	10075.000	20.000	250.000	150.000	0.000	0.000	0.000
X2	0.000	993.820	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GR	1004.000	8637.000	1002.000	8692.000	1000.000	8992.000	998.000	9487.000	996.000	9682.000
GR	994.000	9812.000	992.000	9837.000	993.000	9925.000	971.300	9925.000	971.300	10075.000
GR	989.000	10075.000	990.500	10077.000	989.200	10077.000	989.400	10101.000	988.000	10195.000
GR	990.000	10335.000	990.000	10405.000	986.700	10745.000	988.000	10815.000	994.000	10845.000
GR	990.000	10915.000	992.000	10925.000	990.000	10945.000	988.000	10950.000	986.000	11025.000
GR	986.000	11055.000	988.000	11115.000	0.000	0.000	0.000	0.000	0.000	0.000
ET	0.000	9.100	9.100	9.100	9.100	9.100	9.100	0.000	9938.000	10063.000
X1	58.000	25.000	9938.000	10063.000	400.000	210.000	470.000	0.000	0.000	0.000
GR	1006.000	8542.000	1004.000	6822.000	1004.000	8952.000	1002.000	9042.000	1000.000	9702.000
GR	997.200	9812.000	996.200	9938.000	971.600	9938.000	971.600	10063.000	988.300	10063.000
GR	991.800	10065.000	988.300	10065.000	988.600	10160.000	989.300	10169.000	990.000	10172.000
GR	992.000	10242.000	992.000	10492.000	990.000	10567.000	988.000	10642.000	986.700	10852.000
GR	988.000	10952.000	988.000	11022.000	986.000	11097.000	986.000	11137.000	988.000	11192.000
EJ	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CCHV= 0.100 CEHV= 0.300
*SECNO 35.000

3470 ENCROACHMENT STATIONS= 9894.0 10155.0 TYPE= 1 TARGET= 261.000

CROSS-SECTION	STATION	BOTTOM ELEVATION	BOTTOM WIDTH	LEFT SLOPE	RIGHT SLOPE
35	127+00	962.8	175'	1:3	1:3
35.5	129+50	963.1	155'	1:3	1:3
36	131+50	963.5	175'	1:3	1:3
37	138+00	964.5	175'	1:3	1:3
38	142+00	965.1	175'	1:3	1:3
39	147+00	965.9	175'	1:3	1:3
40	151+30	966.5	175'	1:3	1:3
40.1	152+40	966.5	200'	1:3	1:3
40.5	153+50	966.9	225'	1:3	1:3
41	155+50	967.1	215'	1:3	1:2.5
42	156+25	967.1	215'	1:3	VERT
42.1	156+70	967.2	215'	VERT	VERT
7TH ST BRIDGE					
42.2	157+35	967.2	215'	VERT	VERT
43	158+50	967.3	215'	1:3	1:3
SILVER CREEK					
44	162+00	967.6	215'	1:3	1:3
45	166+00	967.9	215'	1:3	1:3
45.5	168+40	968.1	170'	1:3	1:3
46	169+60	968.2	168'	1:2	VERT
47.5	171+35	968.3	160'	VERT	VERT
48	172+50	968.4	155'	1:2	VERT
48.1	174+05	968.6	151'	VERT	VERT
RAILROAD BRIDGE					
48.2	174+40	968.6	151'	VERT	VERT
49	175+60	968.7	145'	VERT	1:2.5
49.1	176+20	968.7	145'	VERT	1:2.5
50	179+00	969.1	145'	VERT	1:2.5
51	180+10	969.2	145'	VERT	1:2.5
51.01	181+80	969.3	145'	VERT	1:2.5
51.05	182+50	969.3	145'	VERT	1:2.5
51.1	184+45	969.3	170'	VERT	VERT
~~CENTER ST BRIDGE~~					
51.2	184+46	969.4	170'	VERT	VERT

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              CENTER ST BRIDGE
             51.3       185+14     969.4      170'       VERT       VERT
             51.4       185+15     969.4      170'       VERT       VERT
               52       186+20     969.6      170'       1:3        VERT
             52.5       188+25     969.7      130'       1:3        1:2
               53       190+70     969.9      130'       1:3        1:2
             53.5       193+00     970.1      130'       1:3        1:2
             53.8       194+45     970.3      130'       1:3        1:3
              BEAR CREEK
               55       198+65     970.6      120'       1:3        1:3
             55.5       202+45     970.9      120'       1:3        1:3
               56       203+45     971.0      120'       1:3        1:3
             56.1       205+30     971.1      149'       VERT       VERT
              3RD AVE BRIDGE
          25' U/S OF N. BROADWAY DAM
    35.00    16.50    979.30     0.00     0.00   979.90     0.60     0.00     0.00    984.70
   22000.       0.    22000.       0.       0.    3548.       0.       0.       0. 100000.00
     0.00     0.00      6.20     0.00    0.000    0.035    0.000    0.000   962.80   9894.00
 0.000614       0.        0.       0.        0        0        0     0.09   243.03  10137.03

*SECNO 35.500
          THIS CS ADDED 15 AUG 86 BY PMF TO MODEL A NARROW AREA
          STATION 129+50
    35.50    16.59    979.69     0.00     0.00   980.06     0.37     0.14     0.02    974.00
   22000.      87.    21888.      25.      92.    4456.      32.      23.       2.    975.00
     0.01     0.94      4.91     0.80    0.070    0.035    0.070    0.000   963.10   9709.50
 0.000495     190.      250.     275.        2        0        0     0.00   417.98  10127.48

*SECNO 36.000
          STATION 131+50 IN SILVER LAKE
    36.00    16.40    979.90     0.00   980.76   980.16     0.26     0.09     0.01    981.50
   22000.       0.    22000.       0.       0.    5401.       0.      46.       4.    993.90
     0.03     0.00      4.07     0.00    0.000    0.035    0.000    0.000   963.50   9650.59
 0.000399     305.      200.     165.        2        0        0     0.00   508.60  10159.19

*SECNO 37.000
          STATION 138+00 IN SILVER LAKE
    37.00    15.58    980.08     0.00     0.00   980.55     0.47     0.33     0.06    979.00
   22000.     108.    21892.       0.     174.    3971.       0.     117.      11.    995.70
     0.06     0.62      5.51     0.00    0.070    0.035    0.000    0.000   964.50   9676.04
 0.000648     260.      650.     630.        2        0        0     0.00   498.88  10174.91

*SECNO 38.000
          STATION 142+00 IN SILVER LAKE
    38.00    15.50    980.60     0.00     0.00   980.71     0.10     0.12     0.04    982.30
   22000.       0.    22000.       0.       0.    8513.       0.     175.      17.    987.50
     0.10     0.00      2.58     0.00    0.000    0.035    0.000    0.000   965.10   9521.66
 0.000177     335.      400.     910.        2        0        0     0.00   868.82  10390.48
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 SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS    BANK ELEV
 Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA     LEFT/RIGHT
 TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN        SSTA
 SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID       ENDST

*SECNO 39.000
          STATION 147+00 IN SILVER LAKE
   39.00      15.93     980.73       0.00       0.00     980.76       0.04       0.05       0.01    981.40
 22000.         0.    22000.          0.         0.    13981.          1.       304.        30.      980.00
    0.19       0.00       1.57       0.08      0.000      0.035      0.070      0.000     964.80   9346.53
0.000065       320.       500.       380.          2          0          0       0.00    1415.65  10762.18

*SECNO 40.000

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      975.10 ELREA=      986.00

          STATION 151+30 IN SILVER LAKE, RIGHT SIDE OF LAKE NON-EFF. FLOW AREA
   40.00      14.18     980.68       0.00       0.00     980.85       0.18       0.05       0.04    975.10
 22000.       1011.    20989.          0.      1242.      6081.          0.       405.        40.     970.30
    0.23       0.81       3.43       0.00      0.070      0.035      0.000      0.000     966.50   9189.18
0.000216       175.       430.       535.          2          0          0       0.00     794.82   9984.00

*SECNO 40.100
          THIS CS ADDED 15 AUG 86 BY PMF TO MODEL A NARROW AREA
          STATION 152+40
   40.10      13.98     980.48       0.00       0.00     980.99       0.51       0.04       0.10    976.00
 22000.       1956.    20044.          0.      1342.      3360.          0.       420.        42.     990.00
    0.23       1.46       5.97       0.00      0.070      0.035      0.000      0.000     966.50   9195.05
1.000702        80.       110.       200.          2          0          0       0.00     626.19   9821.25

*SECNO 40.500

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE,ELLEA=      975.90 ELREA=      986.00

          STATION 153+50 ENTRANCE TO SILVER LAKE
   40.50      13.68     980.58       0.00       0.00     981.06       0.48       0.07       0.00    975.90
 22000.       1344.    20656.          0.      1058.      3606.          0.       430.        43.     986.00
    0.24       1.27       5.73       0.00      0.070      0.035      0.000      0.000     966.90   9535.35
0.000651        40.       110.       130.          2          0          0       0.00     618.49  10153.83

*SECNO 41.000

3470 ENCROACHMENT STATIONS=    9795.0    10171.0   TYPE=     1  TARGET=     376.000
          STATION 155+50 D/S END OF CONTRACTION, D/S 7TH ST. NF BRIDGE
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        RIGHT BANK BIKEPATH AT EL 980 ADDED  16 AUG 86
   41.00     13.53    980.63     0.00      0.00    981.25     0.62     0.14      0.04    976.50
 22000.       412.    21588.       0.       268.    3399.       0.      446.       44.    986.00
    0.25      1.54      6.35     0.00     0.070     0.035    0.000    0.000    967.10   9795.00
0.000848       50.      200.     120.         2         0        0     0.00    351.90  10146.90

*SECNO 42.000

3470 ENCROACHMENT STATIONS=    9814.0   10168.0  TYPE=     1  TARGET=     354.000
        STATION 156+25 U/S END OF CONTRACTION, D/S 7TH ST NF
        RIGHT BANK BIKEPATH ADDED AT EL 983 (INCLUDES RAILING) 15 AUG 86
        LB FILL TO EL 976 ADDED 16 AUG 86 BY PMF
   42.00     13.53    980.63     0.00    987.33    981.35     0.72     0.07      0.03    976.00
 22000.       374.    21626.       0.       218.    3161.       0.      453.       45.    986.00
    0.25      1.72      6.84     0.00     0.070     0.035    0.000    0.000    967.10   9814.00
0.000961      150.       75.     100.         2         0        0     0.00    299.01  10113.01

CCHV=   0.300 CEHV=   0.500
*SECNO 42.100

3265 DIVIDED FLOW

3370 NORMAL BRIDGE,NRD= 53 MIN ELTRD=  985.13 MAX ELLC=  998.00

        7TH ST. NF BRIDGE
        RIGHT BANK BIKEPATH INCLUDED   15 AUG 86
   42.10     13.38    980.58     0.00      0.00    981.52     0.94     0.06      0.11    990.00
 22000.         0.    22000.       0.        0.    2826.        0.      456.       45.    989.90
    0.25      0.00      7.79     0.00     0.000     0.035    0.000    0.000    967.20   9687.88
0.001935       50.       45.      50.         2         0        0     0.00    225.66   9919.12

CCHV=   0.100 CEHV=   0.300
*SECNO 42.200

3265 DIVIDED FLOW

3370 NORMAL BRIDGE,NRD= 53 MIN ELTRD=  985.13 MAX ELLC=  998.00

        7TH ST  NF BRIDGE
        RIGHT BANK BIKE PATH INCLUDED   15 AUG 86
   42.20     13.53    980.73     0.00    987.27    981.64     0.92     0.12      0.00    990.00
 22000.         0.    22000.       0.        0.    2859.        0.      460.       45.    989.90
    0.25      0.00      7.69     0.00     0.000     0.035    0.000    0.000    967.20   9687.88
0.001869       45.       65.      45.         2         0        0     0.00    225.68   9919.14
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 SECNO      DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     BANK ELEV
 Q          QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
 TIME       VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
 SLOPE      XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

*SECNO 43.000
          STATION 158+50  110' D/S OF SILVER CREEK CONFLUENCE
          LB FILL TO EL 983 ADDED 16 AUG 86 BY PMF
   43.00     13.90    981.20      0.00      0.00    981.81      0.60      0.13      0.03    983.00
  22000.        0.    21714.      286.        0.     3459.      182.      469.       46.    972.50
    0.26      0.00      6.28      1.57     0.000     0.035     0.070     0.000    967.30   9851.39
0.000750      100.      115.      100.         2         0         0      0.00    326.63  10178.01

*SECNO 44.000

3470 ENCROACHMENT STATIONS=    8035.0    10250.0  TYPE=      1  TARGET=    2215.000
          STATION 162+00
   44.00     13.93    981.53      0.00      0.00    982.07      0.54      0.26      0.01    982.00
  21500.        0.    21109.      391.        0.     3560.      268.      500.       49.    977.70
    0.28      0.00      5.93      1.46     0.000     0.035     0.070     0.000    967.60   9851.40
0.000693      145.      350.      650.         2         0         0      0.00    353.41  10204.81

*SECNO 45.000
          STATION 166+00 D/S END OF EXPANSION
          LOW PT IN LB ROAD IS AT THIS CS-981.8
          LOW LB BUILDING AT >984 FROM TOPOG
          BIKE PATH AND SEWER FILL ADDED TO RB  15 AUG 86
   45.00     13.90    981.80      0.00      0.00    982.36      0.56      0.28      0.01    983.00
  21500.        0.    21358.      142.        0.     3534.      101.      535.       53.    977.00
    0.29      0.00      6.04      1.40     0.000     0.035     0.070     0.000    967.90   9850.67
1.000716      330.      400.      530.         2         0         0      0.00    312.39  10163.07

*SECNO 45.500
          STATION 168+40 U/S END OF EXPANSION
          BIKE PATH AND SEWER FILL ADDED TO RB  15 AUG 86
   45.50     13.71    981.81      0.00      0.00    982.66      0.86      0.22      0.09    983.80
  21500.        0.    21441.       59.        0.     2864.       49.      553.       54.    979.00
    0.30      0.00      7.40      1.20     0.000     0.035     0.070     0.000    968.10   9874.97
0.001164      230.      240.      170.         2         0         0      0.00    268.45  10143.42

*SECNO 46.000
          STATION 169+60 D/S OF POWER PLANT DAM (DAM TO BE REMOVED)
          VERTICAL WALL ADDED TO RB  15 AUG 86
   46.00     13.64    981.84      0.00      0.00    982.86      1.03      0.15      0.05    983.80
  21500.        0.    21500.        0.        0.     2644.        0.      561.       55.    983.00
    0.31      0.00      8.13      0.00     0.000     0.035     0.000     0.000    968.20   9887.90
0.001356       70.      120.      160.         2         0         0      0.00    211.19  10099.09
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 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
 Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

*SECNO 47.500
         STATION 171+35 MIDDLE OF CURVE. VERTICAL WALL ON LEFT.
         VERTICAL WALL ADDED TO RB  15 AUG 86
   47.50     13.67    981.97      0.00      0.00    983.17      1.19      0.25      0.05    986.00
. 21500.        0.    21500.        0.        0.     2454.        0.      571.       56.    984.00
    0.31      0.00      8.76      0.00     0.000     0.035     0.000     0.000    968.30   9920.32
0.001533      400.      175.      170.         2         0         0      0.00    184.76  10105.08

*SECNO 48.000
         STATION 172+50 D/S OF C&NW RR BRIDGE
         VERTICAL WALL ADDED TO RB 15 AUG 86
   48.00     13.72    982.12      0.00      0.00    983.36      1.25      0.18      0.02    992.00
  21500.        0.    21500.        0.        0.     2401.        0.      578.       56.    985.00
    0.32      0.00      8.96      0.00     0.000     0.035     0.000     0.000    968.40   9893.91
0.001650      170.      115.       85.         2         0         0      0.00    188.16  10082.08

CCHV=    0.300 CEHV=    0.500
*SECNO 48.100

3470 ENCROACHMENT STATIONS=    9905.0   10075.0   TYPE=     1  TARGET=     170.000
         CHICAGO & NORTHWESTERN RAILROAD BRIDGE
   48.10     13.60    982.20      0.00      0.00    983.88      1.68      0.30      0.22    994.40
  21500.        0.    21500.        0.        0.     2065.        0.      585.       57.    995.00
    0.32      0.00     10.41      0.00     0.000     0.035     0.000     0.000    968.60   9914.05
0.002305      425.      155.      195.         2         0         0      0.00    151.90  10065.95


SPECIAL BRIDGE

5470,VARIABLE ELCHU OR ELCHD ON CARD SB NOT SPECIFIED
SB  XK       XKOR      COFQ      RDLEN     BWC       BWP       BAREA       SS       ELCHU     ELCHD
    1.05     1.40      2.50      0.00      152.00    12.40     2500.00     0.00     968.60    968.60

*SECNO 48.200
CLASS A LOW FLOW

3420 BRIDGE W.S.=     981.73 BRIDGE VELOCITY=.     11.73      CALCULATED CHANNEL AREA=.     1834.
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 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
 Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA     LEFT/RIGHT
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN      SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID     ENDST


LGFRS      EGLWC       H3        QWEIR      QLOW      HAREA   TRAPEZOID     ELLC      ELTRD
                                                                 AREA
    0.00     984.26      0.49        0.     21500.     2500.     2485.     986.40    993.90


3470 ENCROACHMENT STATIONS=    9905.0   10075.0  TYPE=     1  TARGET=    170.000
          CHICAGO & NORTHWESTERN RAILROAD BRIDGE
    48.20     14.09    982.69      0.00      0.00    984.26      1.57      0.38      0.00    994.40
   21500.        0.    21500.        0.        0.     2140.        0.      587.       57.    995.00
     0.32      0.00     10.05      0.00     0.000     0.035     0.030     0.000    968.60   9914.05
 0.002064       50.       35.       50.         0         0         0      0.00    151.91  10065.95


*SECNO 49.000
          STATION 175+60 U/S OF C&NW RR BRIDGE
          LEFT SIDE VERT, RIGHT SIDE 1:2.5 145 FT RW
    49.00     14.61    983.31      0.00      0.00    984.57      1.26      0.22      0.09    984.60
   21500.        0.    21500.        0.        0.     2388.        0.      593.       57.    988.50
     0.33      0.00      9.00      0.00     0.000     0.035     0.000     0.000    968.70   9900.01
 0.001640      250.      120.      260.         2         0         0      0.00    181.89  10081.90


*SECNO 49.100
          STATION 176+20
    49.10     14.76    983.46      0.00      0.00    984.68      1.22      0.10      0.01    984.60
   21500.        0.    21500.        0.        0.     2423.        0.      597.       57.    989.00
     0.33      0.00      8.87      0.00     0.000     0.035     0.000     0.000    968.70   9905.01
 0.001579       60.       60.       60.         2         0         0      0.00    183.52  10088.53


CCHV=    0.100 CEHV=    0.300
*SECNO 50.000
          STATION 179+00
    50.00     14.79    983.89      0.00      0.00    985.12      1.23      0.44      0.00    986.00
   21500.        0.    21500.        0.        0.     2419.        0.      612.       59.    999.00
     0.34      0.00      8.89      0.00     0.000     0.035     0.000     0.000    969.10   9908.01
 0.001575      180.      280.      145.         2         0         0      0.00    182.10  10090.11


*SECNO 51.000
          STATION 180+10
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 SECNO     DEPTH     CWSEL     CRIWS     WSELK      EG        HV        HL       OLOSS    BANK ELEV
   Q       QLOB      QCH       QROB      ALOB       ACH       AROB      VOL      TWA    LEFT/RIGHT
 TIME      VLOB      VCH       VROB      XNL        XNCH      XNR       WTN      ELMIN       SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL     IDC       ICONT     CORAR    TOPWID      ENDST

   51.00     14.88    984.08     0.00      0.00     985.29     1.21      0.17      0.00    991.70
 21500.        0.    21500.       0.        0.      2432.       0.      618.       59.     997.70
    0.34      0.00      8.84     0.00     0.000     0.035     0.000     0.000   969.20   9895.03
0.001547     130.      110.     110.         0         0         0      0.00   182.03  10077.07

*SECNO 51.010
          STATION 181+80
   51.01     15.07    984.37     0.00      0.00     985.56     1.18      0.26      0.00    991.60
 21500.        0.    21500.       0.        0.      2465.       0.      628.       60.     997.70
    0.34      0.00      8.72     0.00     0.000     0.035     0.000     0.000   969.30   9915.03
0.001483     170.      170.     170.         2         0         0      0.00   182.12  10097.15

*SECNO 51.050
          STATION 182+50 D/S OF CENTER ST. BRIDGE
   51.05     15.20    984.50     0.00      0.00     985.66     1.16      0.10      0.00    991.60
 21500.        0.    21500.       0.        0.      2488.       0.      632.       60.     997.70
    0.35      0.00      8.64     0.00     0.000     0.035     0.000     0.000   969.30   9915.03
0.001443      30.       70.      70.         2         0         0      0.00   182.43  10097.46

CLHV=   0.300 CEHV=   0.500
*SECNO 51.100
          CENTER ST. BRIDGE
          BIKE PATH AT 984.5 (INCLUDES RAILING)
   51.10     15.66    984.96     0.00      0.00     985.96     1.00      0.26      0.05    992.70
 21500.        0.    21500.       0.        0.      2673.       0.      644.       61.     994.80
    0.35      0.00      8.04     0.00     0.000     0.035     0.000     0.000   969.30   9914.33
0.001217     120.      195.     300.         2         0         0      0.00   180.71  10095.04

CLHV=   0.300 CEHV=   0.500
*SECNO 51.200

3265 DIVIDED FLOW

3371 NORMAL BRIDGE,NRD= 19 MIN ELTRD=   990.00 MAX ELLC= 1000.00

          CENTER ST. BRIDGE
          BIKE PATH AT 984.5
   51.20     15.53    984.93     0.00    990.00     996.00     1.07      0.00      0.03    992.70
 21500.        0.    21500.       0.        0.      2587.       0.      644.       61.     994.80
    0.35      0.00      8.31     0.00     0.090     0.035     0.090     0.000   969.40   9914.33
0.001875       1.        1.       1.         2         0         0      0.00   176.71  10095.04
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 SECNO      DEPTH     CWSEL     CRIWS     WSELK      EG        HV        HL       OLOSS   BANK ELEV
 Q          QLOB      QCH       QROB      ALOB       ACH       AROB      VOL      TWA    LEFT/RIGHT
 TIME       VLOB      VCH       VROB      XNL        XNCH      XNR       WTN      ELMIN      SSTA
 SLOPE      XLOBL     XLCH      XLOBR     ITRIAL     IDC       ICONT     CORAR    TOPWID     ENDST

*SECNO 51.300

3265 DIVIDED FLOW

3370 NORMAL BRIDGE,NRD= 19 MIN ELTRD=  990.00 MAX ELLC= 1000.00

    51.30    15.68    985.08      0.00      0.00    986.13      1.05      0.13      0.01    992.70
   21500.       0.    21500.        0.        0.     2614.        0.      648.       61.    994.80
     0.36     0.00      8.22      0.00     0.000     0.035     0.000     0.000    969.40   9914.33
 0.001819      68.       68.       68.         2         0         0      0.00    176.73 10095.06

*SECNO 51.400
    51.40    15.76    985.16      0.00      0.00    986.15      0.99      0.00      0.02    992.70
   21500.       0.    21500.        0.        0.     2692.        0.      648.       61.    994.80
     0.36     0.00      7.99      0.00     0.000     0.035     0.000     0.000    969.40   9914.32
 0.001190       1.        1.        1.         2         0         0      0.00    180.74 10095.06

*SECNO 52.000
          STATION 186+20 D/S END OF EXPANSION
          RR BIKE PATH AT 990 (INCLUDES RAILING)
    52.00    16.07    985.67      0.00    992.69    986.34      0.68      0.10      0.09    987.00
   21500.       0.    21500.        0.        0.     3255.        0.      655.       62.    990.00
     0.36     0.00      6.60      0.00     0.000     0.035     0.000     0.000    969.60   9866.98
 0.000761     250.      105.       10.         2         0         0      0.00    228.09 10095.07

CEHV=    0.100 CEHV=    0.300
*SECNO 52.500
           STATION 188+25  U/S END OF CONTRACTION
    52.50    15.96    985.66      0.00      0.00    986.61      0.95      0.19      0.08    983.90
   21500.     153.    21347.        0.      267.     2714.        1.      669.       63.    985.00
     0.37     0.57      7.86      0.29     0.080     0.035     0.080     0.000    969.70   9598.22
 0.001130     170.      205.      140.         2         0         0      0.00    509.64 10107.87

*SECNO 53.000
          STATION 190+70
    53.00    16.03    985.93      0.00      0.00    986.90      0.97      0.28      0.00    986.30
   21500.       0.    21500.        0.        0.     2724.        0.      685.       65.    991.50
     0.38     0.00      7.89      0.00     0.000     0.035     0.000     0.000    969.90   9887.09
 0.001178     115.      245.      230.         2         0         0      0.00    209.83 10096.92
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 SECNO      DEPTH     CWSEL     CRIWS     WSELK      EG        HV        HL       OLOSS    BANK ELEV
 Q          QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
 TIME       VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
 SLOPE      XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

*SECNO 53.500
          STATION 193+00  D/S OF BEAR CREEK CONFLUENCE
   53.50     16.12    986.22      0.00      0.00    987.16      0.94      0.25      0.00    984.00
 21500.       156.    21230.      115.      276.     2707.       98.      701.       67.    980.70
   0.38       0.56      7.84      1.17     0.080     0.035     0.080     0.000    970.10   9309.39
 0.001012     235.      230.      340.         2         0         0      0.00    729.11  10038.51

*SECNO 53.800
         STATION 194+65
   53.80     16.19    986.49      0.00      0.00    987.33      0.84      0.17      0.01    984.00
 21500.       167.    21311.       22.      326.     2880.       33.      712.       69.    984.00
   0.39       0.51      7.40      0.67     0.080     0.035     0.080     0.000    970.30   9289.42
 0.000969     100.      165.      100.         2         0         0      0.00    744.73  10034.15

*SECNO 55.000

3470 ENCROACHMENT STATIONS=    9889.0   10110.0   TYPE=     1  TARGET=     221.000
          STATION 198+65
   55.00     16.52    987.12      0.00      0.00    987.68      0.56      0.32      0.03    985.00
 16800.        10.    16778.       12.       15.     2803.       17.      739.       72.    984.60
   0.41       0.65      5.99      0.70     0.080     0.035     0.080     0.000    970.60   9889.00
 0.000634      40.      400.     1030.         2         0         0      0.00    221.00  10110.00

*SECNO 55.500

3470 ENCROACHMENT STATIONS=    9886.0   10123.0   TYPE=     1  TARGET=     237.000
          STATION 202+45 D/S END OF CONTRACTION AND CHANNEL TRANSITION
   55.50     16.47    987.37      0.00      0.00    987.93      0.56      0.25      0.00    986.10
 16800.         6.    16794.        0.       11.     2794.        0.      763.       74.    989.10
   0.43       0.52      6.01      0.00     0.080     0.035     0.000     0.000    970.90   9886.00
 0.000680      20.      380.      390.         2         0         0      0.00    223.77  10109.77

*SECNO 56.000

3470 ENCROACHMENT STATIONS=    9917.0   10132.0   TYPE=     1  TARGET=     215.000
          STATION 203+45 U/S END OF CONTRACTION & CHANNEL TRANSITION
          RR BIKE PATH ADDED 16 AUG 86 BY PMF
   56.00     16.42    987.42      0.00      0.00    988.00      0.59      0.07      0.01    989.10
 16800.         0.    16800.        0.        0.     2731.        0.      770.       74.    990.00
   0.43       0.00      6.15      0.00     0.000     0.035     0.000     0.000    971.00   9917.09
 0.000631      50.      100.       50.         0         0         0      0.00    170.99  10088.08
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 SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS    BANK ELEV
 Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
 TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
 SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST

CCHV=   0.300 CEHV=    0.500
*SECNO 56.100

3470 ENCROACHMENT STATIONS=    9903.0    10064.0   TYPE=     1  TARGET=     161.000
    56.10     16.38    987.48      0.00      0.00    988.21      0.73      0.13      0.07    994.50
   16800.        0.    16800.        0.        0.     2453.        0.      781.       75.    991.50
     0.44      0.00      6.85      0.00     0.000     0.035     0.000     0.000    971.10   9903.30
 0.000810       20.      185.      190.         2         0         0      0.00    150.50  10053.80

*SECNO 56.200

3265 DIVIDED FLOW

3370 NORMAL BRIDGE,NRD= 10 MIN ELTRD=  990.00 MAX ELLC= 1004.00

3470 ENCROACHMENT STATIONS=    9903.0    10064.0   TYPE=     1  TARGET=     161.000
          2ND AVE. SE BRIDGE
          RB BIKE PATH ADDED 16 AUG 86 BY PMF
    56.20     16.36    987.46      0.00      0.00    988.23      0.77      0.00      0.02    994.50
   16800.        0.    16800.        0.        0.     2379.        0.      781.       75.    991.50
     0.44      0.00      7.06      0.00     0.000     0.035     0.000     0.000    971.10   9903.30
 0.001308        1.        1.        1.         2         0         0      0.00    147.89  10053.80

*SECNO 56.300

3265 DIVIDED FLOW

3370 NORMAL BRIDGE,NRD= 10 MIN ELTRD=  990.00 MAX ELLC= 1004.00

3470 ENCROACHMENT STATIONS=    9903.0    10064.0   TYPE=     1  TARGET=     161.000
          2ND AVE SE BRIDGE
          RB BIKE PATH ADDED 16 AUG 86 BY PMF
    56.30     16.46    987.56      0.00      0.00    988.32      0.76      0.09      0.00    994.50
   16800.        0.    16800.        0.        0.     2394.        0.      785.       75.    991.50
     0.44      0.00      7.02      0.00     0.000     0.035     0.000     0.000    971.10   9903.30
 0.001285       70.       70.       70.         2         0         0      0.00    147.92  10053.81
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   SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS    BANK ELEV
   Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA     LEFT/RIGHT
   TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN       SSTA
   SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID      ENDST

*SECNO 56.400

3470 ENCROACHMENT STATIONS=     9903.0     10064.0   TYPE=      1  TARGET=       161.000
    56.40      16.52     987.62       0.00       0.00     988.34      0.72       0.00       0.01     994.50
   16800.         0.     16800.         0.         0.      2475.        0.       785.        75.     991.50
     0.44       0.00       6.79       0.00      0.000      0.035     0.000      0.000     971.10    9903.29
 0.000788         1.         1.         1.          2          0         0       0.00     150.52  10053.81

CCHV=    0.100 CEHV=    0.300
*SECNO 57.000

3470 ENCROACHMENT STATIONS=     9925.0     10075.0   TYPE=      1  TARGET=       150.000
       STATION 207+75 U/S END OF STUDY
    57.00      16.44     987.74       0.00     993.82     988.46      0.72       0.12       0.00     993.00
   16800.         0.     16800.         0.         0.      2466.        0.       793.        76.  100000.00
     0.45       0.00       6.81       0.00      0.000      0.035     0.000      0.000     971.30    9925.00
 0.000802        20.       150.       250.          2          0         0       0.00     150.00  10075.00

*SECNO 58.000

3470 ENCROACHMENT STATIONS=     9938.0     10063.0   TYPE=      1  TARGET=       125.000
    58.00      16.37     987.97       0.00       0.00     989.02      1.05       0.46       0.10     996.20
   16800.         0.     16800.         0.         0.      2047.        0.       817.        77.  100000.00
     0.46       0.00       8.21       0.00      0.000      0.035     0.000      0.000     971.60    9938.00
 0.001226       400.       470.       210.          2          0         0       0.00     125.00  10063.00
```

THIS RUN EXECUTED 19 DEC 86 14:02:26

```
**************************************************
HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56
**************************************************
```

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

5TSH FLOOD Q=22000 CFS A

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
35.000	0.00	0.00	0.00	962.80	22000.00	979.30	0.00	979.90	6.44	6.20	3547.54	8665.92
35.500	250.00	0.00	0.00	963.10	22000.00	979.69	0.00	980.06	4.95	4.91	4579.57	9891.67
36.000	200.00	0.00	0.00	963.50	22000.00	979.90	0.00	980.16	3.99	4.07	5401.39	11018.76
37.000	650.00	0.00	0.00	964.50	22000.00	980.08	0.00	980.55	6.48	5.51	4144.49	8641.42
38.000	400.00	0.00	0.00	965.10	22000.00	980.60	0.00	980.71	1.77	2.58	8512.51	16520.51
39.000	500.00	0.00	0.00	964.80	22000.00	980.73	0.00	980.76	0.65	1.57	13981.51	27314.70
40.000	430.00	0.00	0.00	966.50	22000.00	980.68	0.00	980.85	2.16	3.45	7323.13	14956.73
40.100	110.00	0.00	0.00	966.50	22000.00	980.48	0.00	980.99	7.02	5.97	4702.28	8305.87
40.500	110.00	0.00	0.00	966.90	22000.00	980.58	0.00	981.06	6.51	5.73	4663.85	8623.87
41.000	200.00	0.00	0.00	967.10	22000.00	980.63	0.00	981.25	8.48	6.35	3666.67	7554.48
42.000	75.00	0.00	0.00	967.10	22000.00	980.63	0.00	981.35	9.61	6.84	3378.97	7096.15
42.100	45.00	965.13	998.00	967.20	22000.00	980.58	0.00	981.52	19.35	7.79	2825.73	5001.58
42.200	65.00	985.13	998.00	967.20	22000.00	980.73	0.00	981.64	18.69	7.69	2859.04	5088.17
43.000	115.00	0.00	0.00	967.30	22000.00	981.20	0.00	981.81	7.50	6.28	3640.96	8033.67
44.000	350.00	0.00	0.00	967.60	21500.00	981.53	0.00	982.07	6.93	5.93	3628.77	8166.69
45.000	400.00	0.00	0.00	967.90	21500.00	981.80	0.00	982.36	7.16	6.04	3634.70	8034.56
45.500	200.00	0.00	0.00	966.10	21500.00	981.81	0.00	982.65	11.64	7.44	2932.38	6301.29

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
46.000	120.00	0.00	0.00	968.20	21500.00	981.84	0.00	982.86	13.56	8.13	2643.94	5839.42
47.500	175.00	0.00	0.00	968.30	21500.00	981.97	0.00	983.17	15.33	8.76	2454.42	5490.49
48.000	115.00	0.00	0.00	968.40	21500.00	982.12	0.00	983.36	16.50	8.96	2400.60	5292.67
48.100	155.00	0.00	0.00	968.60	21500.00	982.20	0.00	983.88	23.05	10.41	2065.38	4477.97
48.200	35.00	993.90	986.40	968.60	21500.00	982.69	0.00	984.26	20.64	10.05	2139.77	4732.72
49.000	120.00	0.00	0.00	968.70	21500.00	983.31	0.00	984.57	16.40	9.00	2387.63	5309.72
49.100	60.00	0.00	0.00	968.70	21500.00	983.46	0.00	984.68	15.79	8.87	2423.12	5410.95
50.000	280.00	0.00	0.00	969.10	21500.00	983.89	0.00	985.12	15.75	8.89	2418.94	5418.20
51.000	110.00	0.00	0.00	969.20	21500.00	984.08	0.00	985.29	15.47	8.84	2432.16	5466.30
51.010	170.00	0.00	0.00	969.30	21500.00	984.37	0.00	985.56	14.83	8.72	2464.68	5582.18
51.050	70.00	0.00	0.00	969.30	21500.00	984.50	0.00	985.66	14.43	8.64	2487.72	5660.68
51.100	195.00	0.00	0.00	969.30	21500.00	984.96	0.00	985.96	12.17	8.04	2672.74	6162.22
51.200	1.00	990.00	1000.00	969.40	21500.00	984.93	0.00	986.00	18.75	8.31	2586.93	4965.15
51.300	68.00	990.00	1000.00	969.40	21500.00	985.08	0.00	986.13	18.19	8.22	2614.25	5041.26
51.400	1.00	0.00	0.00	969.40	21500.00	985.16	0.00	986.15	11.90	7.99	2692.06	6232.63
52.000	105.00	0.00	0.00	969.60	21500.00	985.67	0.00	986.34	7.61	6.60	3255.25	7794.03
52.500	205.00	0.00	0.00	969.70	21500.00	985.66	0.00	986.61	11.30	7.86	2981.79	6394.54
53.000	245.00	0.00	0.00	969.90	21500.00	985.93	0.00	986.90	11.78	7.89	2724.40	6263.48
53.500	230.00	0.00	0.00	970.10	21500.00	986.22	0.00	987.16	10.42	7.84	3081.04	6661.10
53.800	165.00	0.00	0.00	970.30	21500.00	986.49	0.00	987.33	9.69	7.40	3239.01	6907.44
55.000	400.00	0.00	0.00	970.60	16800.00	987.12	0.00	987.68	6.34	5.99	2834.95	6672.19
55.500	380.00	0.00	0.00	970.90	16800.00	987.37	0.00	987.93	6.80	6.01	2804.73	6443.67
56.000	100.00	0.00	0.00	971.00	16800.00	987.42	0.00	988.00	6.31	6.15	2731.10	6686.73
56.100	185.00	0.00	0.00	971.10	16800.00	987.48	0.00	988.21	8.10	6.85	2452.56	5901.69
56.200	1.00	990.00	1004.00	971.10	16800.00	987.46	0.00	988.23	13.08	7.06	2378.85	4644.56
56.300	70.00	990.00	1004.00	971.10	16800.00	987.56	0.00	988.32	12.85	7.02	2394.18	[illegible]686.48

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01K
56.400	1.00	0.00	0.00	971.10	16600.00	987.62	0.00	988.34	7.88	6.79	2474.54	5983.81
57.000	150.00	0.00	0.00	971.30	16800.00	987.74	0.00	988.46	8.02	6.61	2465.92	5931.68
58.000	470.00	0.00	0.00	971.60	16800.00	987.97	0.00	989.02	12.26	8.21	2046.55	4797.95

SIGN FLOOD Q=22000 CFS A

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
35.000	22000.00	979.30	0.00	0.00	0.00	243.03	0.00
35.500	22000.00	979.69	0.00	0.39	0.00	417.98	250.00
36.000	22000.00	979.90	0.00	0.22	-6.86	508.60	200.00
37.000	22000.00	980.08	0.00	0.18	0.00	498.88	650.00
38.000	22000.00	980.60	0.00	0.52	0.00	868.82	400.00
39.000	22000.00	980.73	0.00	0.12	0.00	1415.65	500.00
40.000	22000.00	980.68	0.00	-0.05	0.00	794.82	430.00
40.100	22000.00	980.48	0.00	-0.19	0.00	626.19	110.00
40.500	22000.00	980.58	0.00	0.10	0.00	618.49	110.00
41.000	22000.00	980.63	0.00	0.05	0.00	351.90	200.00
42.000	22000.00	980.63	0.00	0.00	-6.70	299.01	75.00
42.100	22000.00	980.58	0.00	-0.05	0.00	225.66	45.00
42.200	22000.00	980.73	0.00	0.15	-6.54	225.68	65.00
43.000	22000.00	981.20	0.00	0.48	0.00	326.63	115.00
44.000	21500.00	981.53	0.00	0.33	0.00	353.41	350.00
45.000	21500.00	981.80	0.00	0.26	0.00	312.39	400.00
45.500	21500.00	981.81	0.00	0.01	0.00	268.45	240.00
46.000	21500.00	981.84	0.00	0.03	0.00	211.19	120.00
47.500	21500.00	981.97	0.00	0.14	0.00	184.76	175.00
48.000	21500.00	982.12	0.00	0.15	0.00	188.16	115.00
48.100	21500.00	982.20	0.00	0.08	0.00	151.90	155.00
48.200	21500.00	982.69	0.00	0.49	0.00	151.91	35.00
49.000	21500.00	983.31	0.00	0.62	0.00	181.89	120.00
[illegible]	21500.00	983.46	0.00	0.14	0.00	[illegible]	60.00

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
50.000	21500.00	983.89	0.00	0.43	0.00	182.10	280.00
51.000	21500.00	984.08	0.00	0.19	0.00	182.03	110.00
51.010	21500.00	984.37	0.00	0.29	0.00	182.12	170.00
51.050	21500.00	984.50	0.00	0.13	0.00	182.43	70.00
51.100	21500.00	984.96	0.00	0.46	0.00	180.71	195.00
51.200	21500.00	984.93	0.00	-0.03	-5.07	176.71	1.00
51.300	21500.00	985.08	0.00	0.15	0.00	176.73	68.00
51.400	21500.00	985.16	0.00	0.08	0.00	180.74	1.00
52.000	21500.00	985.67	0.00	0.51	-7.02	228.09	105.00
52.500	21500.00	985.66	0.00	-0.01	0.00	509.64	205.00
53.000	21500.00	985.93	0.00	0.27	0.00	209.83	245.00
53.500	21500.00	986.22	0.00	0.28	0.00	729.11	230.00
53.800	21500.00	986.49	0.00	0.28	0.00	744.73	165.00
55.000	16800.00	987.12	0.00	0.63	0.00	221.00	400.00
55.500	16800.00	987.37	0.00	0.25	0.00	223.77	380.00
56.000	16800.00	987.42	0.00	0.05	0.00	170.99	100.00
56.100	16800.00	987.48	0.00	0.06	0.00	150.50	185.00
56.200	16800.00	987.46	0.00	-0.02	0.00	147.89	1.00
56.300	16800.00	987.56	0.00	0.10	0.00	147.92	70.00
56.400	16800.00	987.62	0.00	0.06	0.00	150.52	1.00
57.000	16800.00	987.74	0.00	0.12	-6.08	150.00	150.00
58.000	16800.00	987.97	0.00	0.23	0.00	125.00	470.00

SUMMARY OF ERRORS AND SPECIAL NOTES

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*****************************************************
 MCC2 RELEASE DATED NOV 76 UPDATED MAY  1984
 ERROR CORR -  01,02,03,04,05,06
 MODIFICATION -  50,51,52,53,54,55,56
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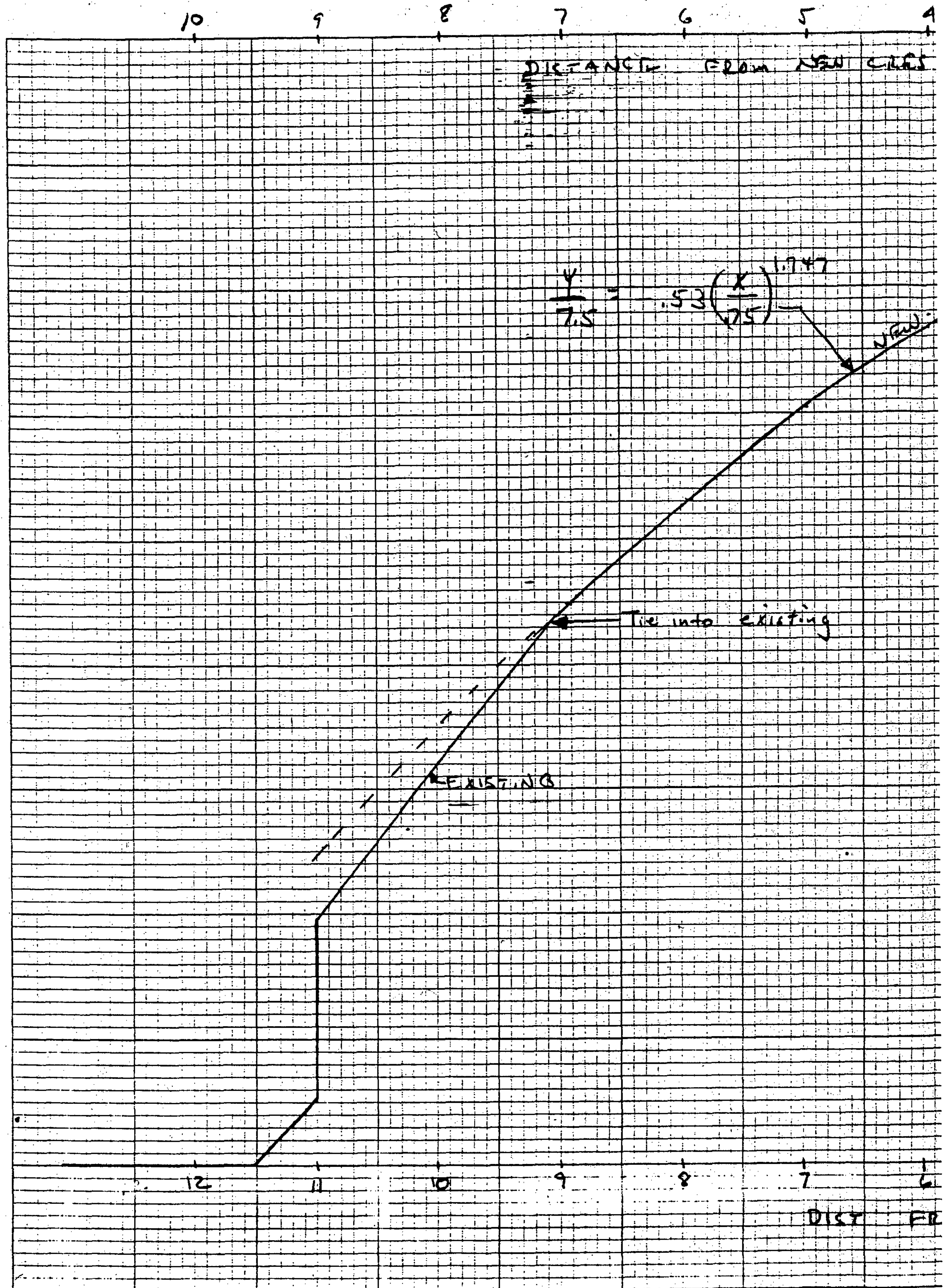
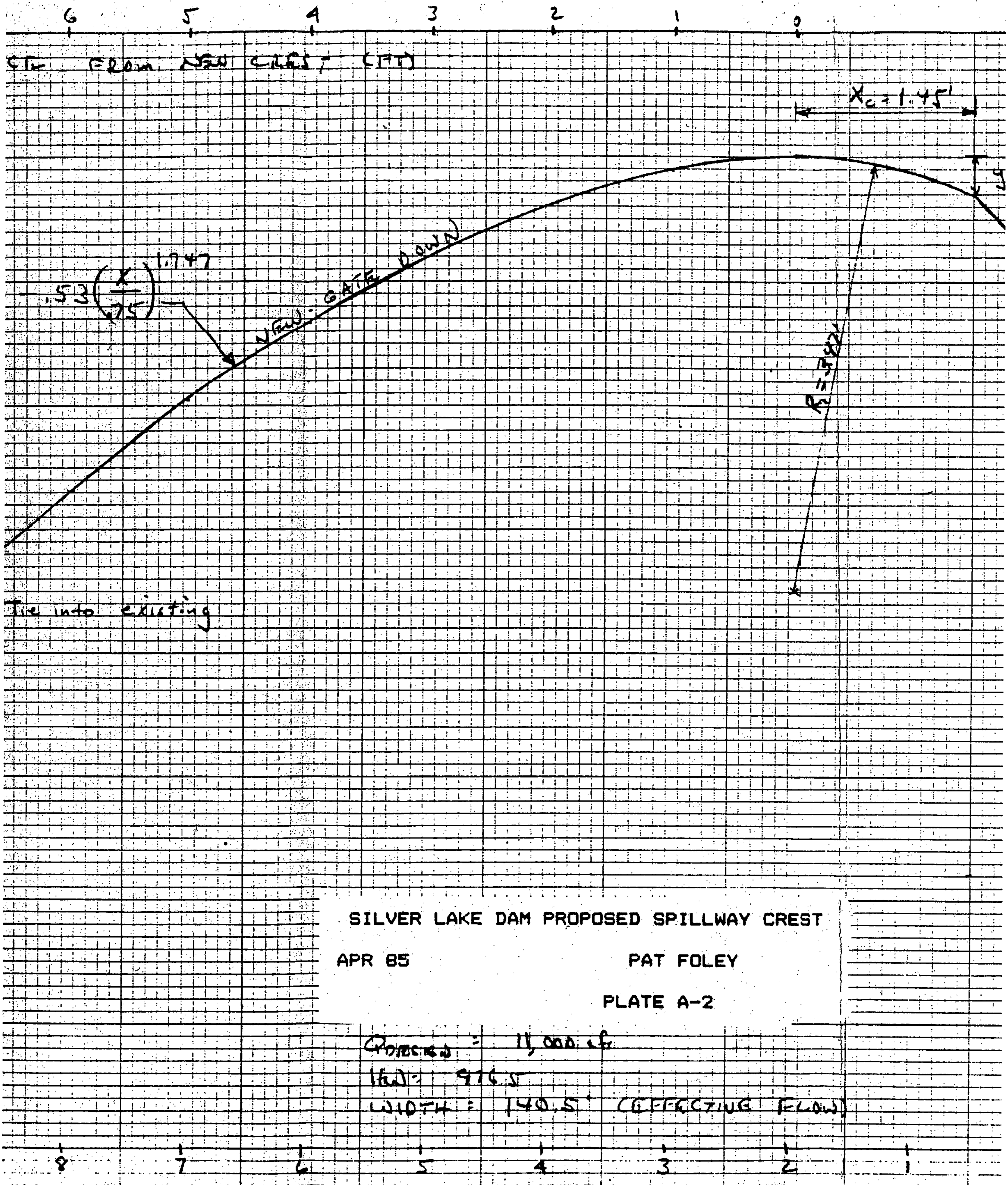
THIS RUN EXECUTED 19 DEC 86   14:02:29


10 9 8 7 6 5 4
DISTANCE FROM NEW CRES
Y/7.5 = .53(X/7.5)^1.747
NEW
Tie into existing
EXISTING
12 11 10 9 8 7 6
DIST FR

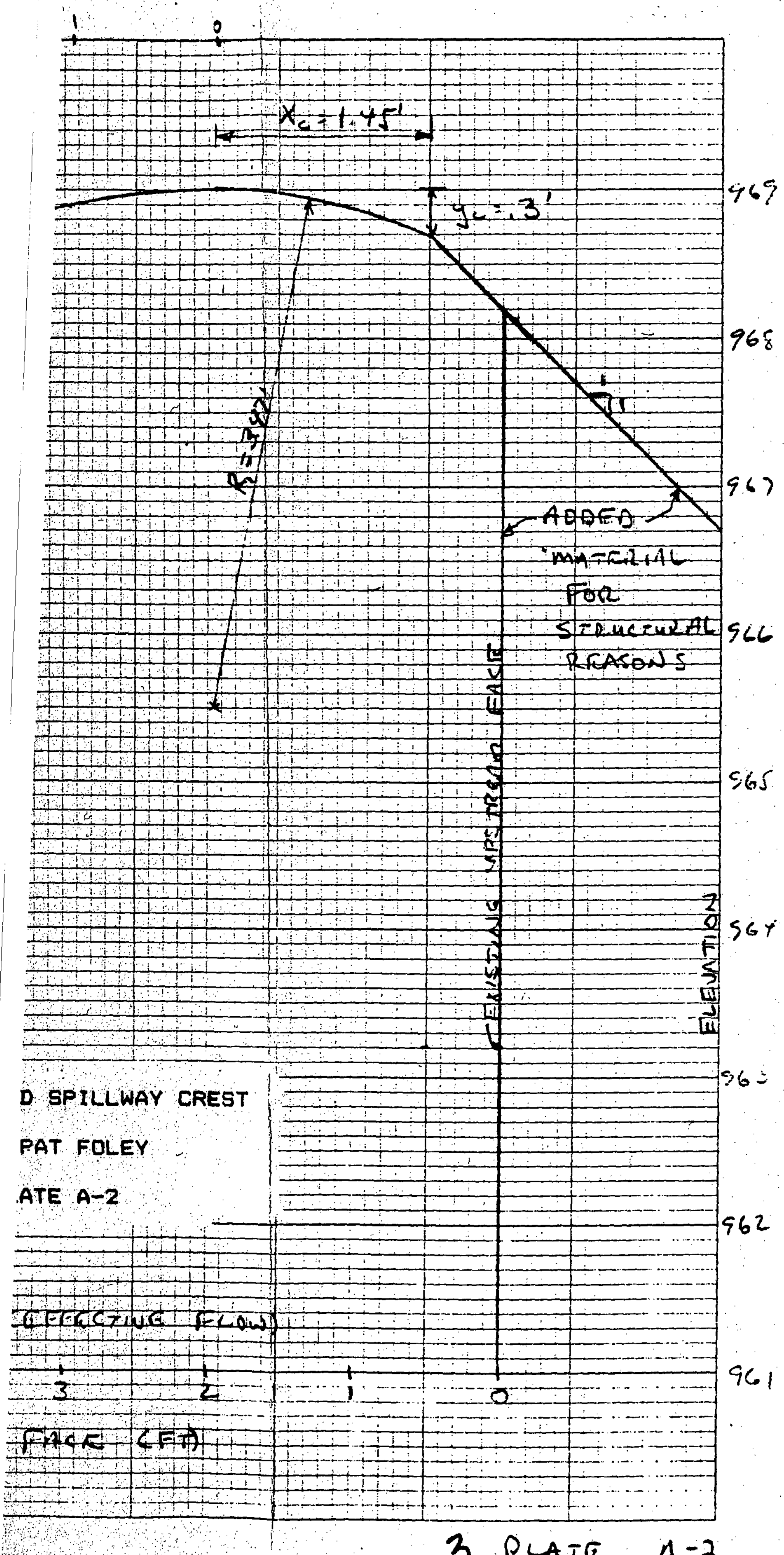


SILVER LAKE DAM PROPOSED SPILLWAY CREST

APR 85 PAT FOLEY

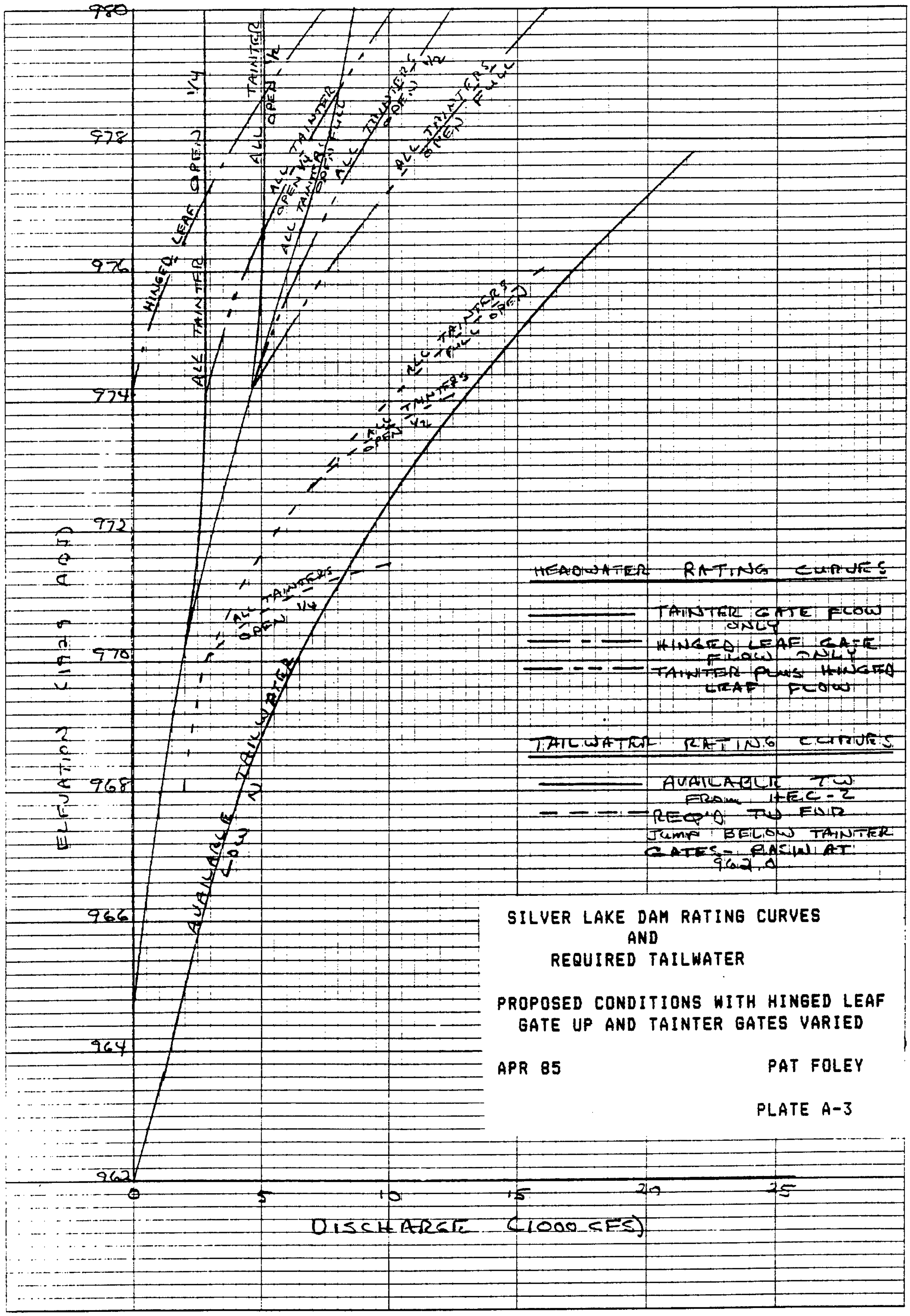
PLATE A-2

Q_{DESIGN} = 11,000 cfs
HW = 976.5
WIDTH = 140.5' (AFFECTING FLOW)



D SPILLWAY CREST
PAT FOLEY
ATE A-2
$X_c = 1.45'$
$y_c = .3'$
R = 3.42'
ADDED MATERIAL FOR STRUCTURAL REASONS
EXISTING UPSTREAM FACE
ELEVATION
969
968
967
966
965
964
963
962
961
EFFECTING FLOW)
FACE (FT)
1
0
3
2
1
0

3 PLATE A-2

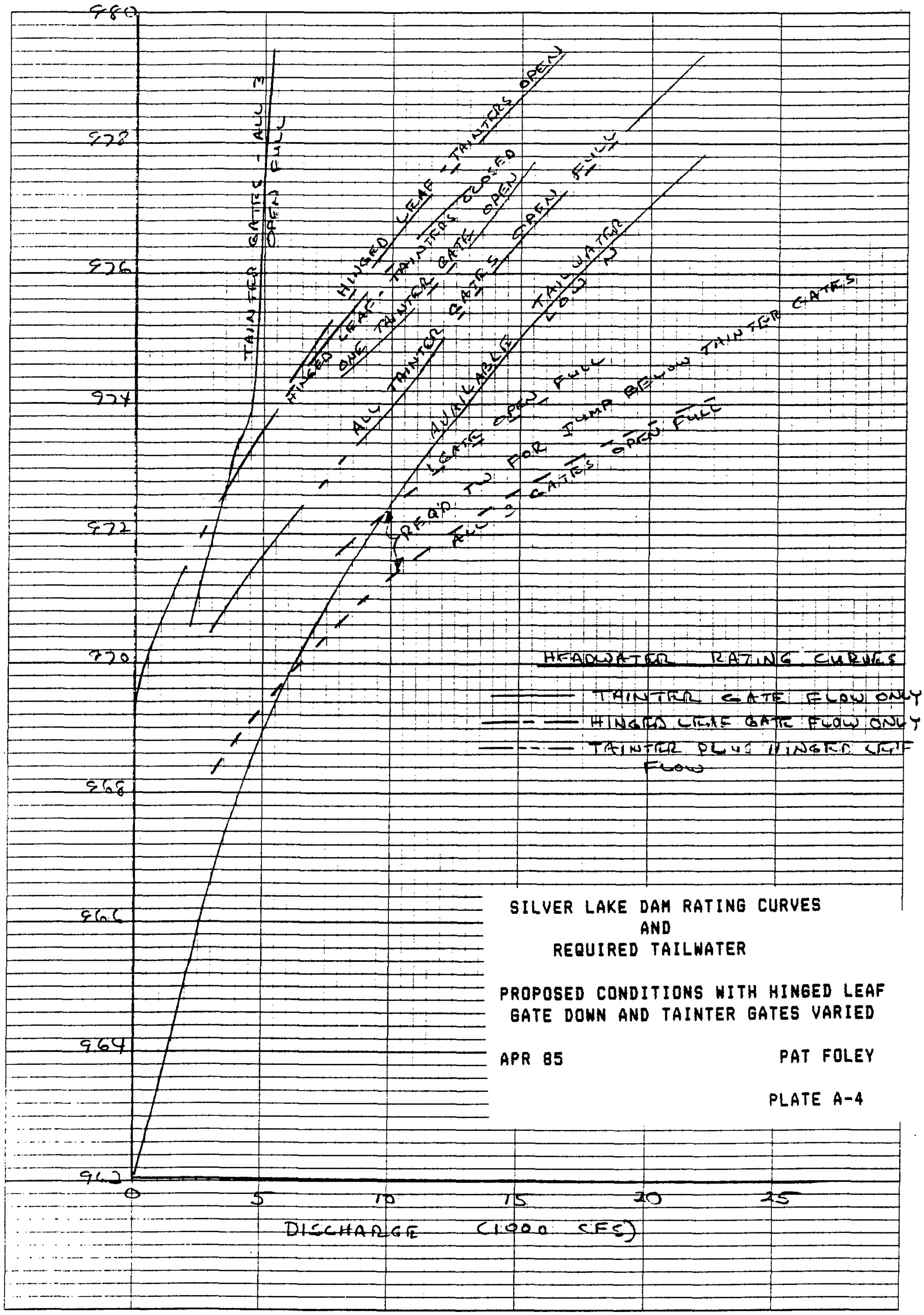


SILVER LAKE DAM RATING CURVES
AND
REQUIRED TAILWATER

PROPOSED CONDITIONS WITH HINGED LEAF
GATE UP AND TAINTER GATES VARIED

APR 85 PAT FOLEY

PLATE A-3

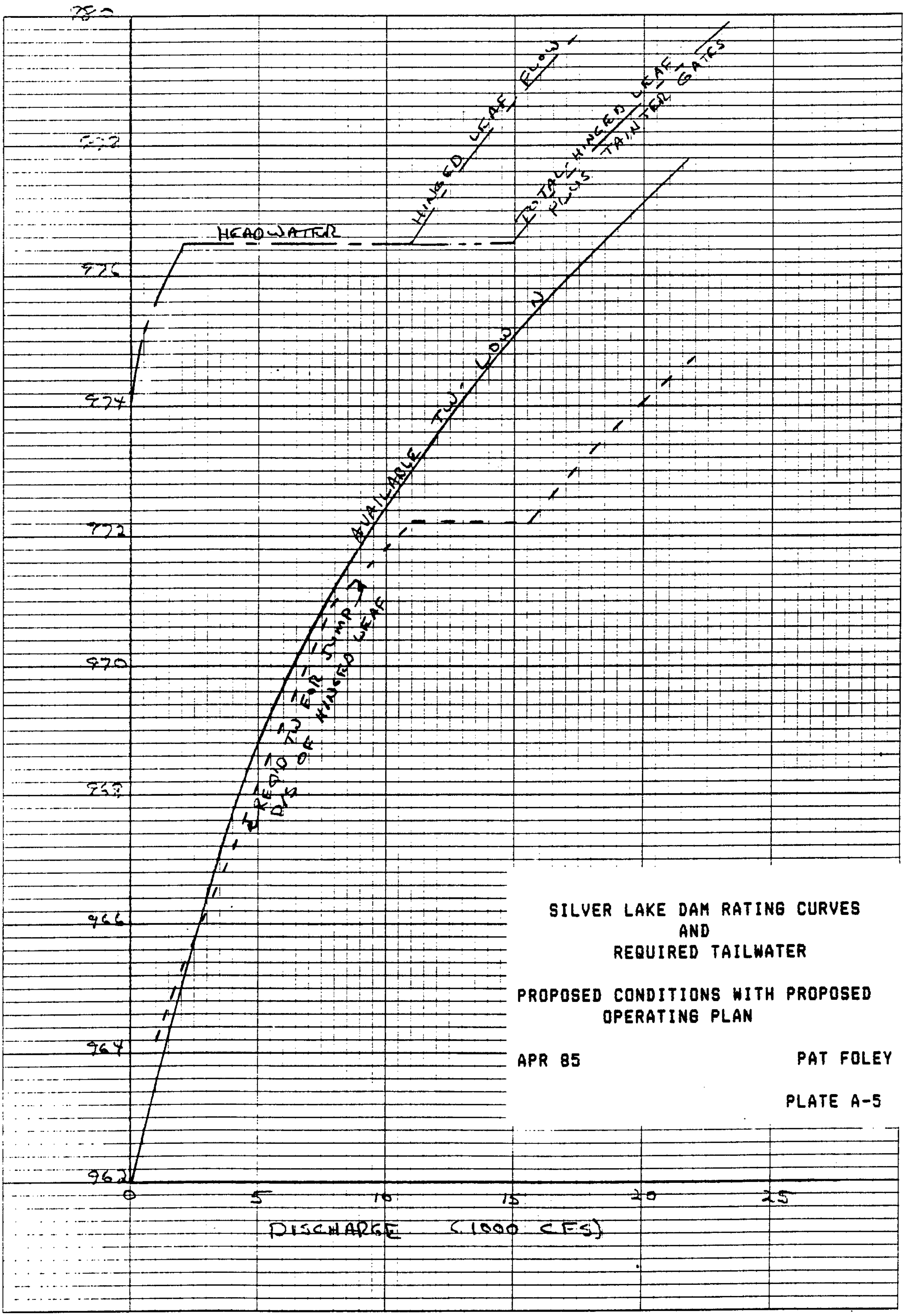


SILVER LAKE DAM RATING CURVES
AND
REQUIRED TAILWATER

PROPOSED CONDITIONS WITH HINGED LEAF
GATE DOWN AND TAINTER GATES VARIED

APR 85 PAT FOLEY

PLATE A-4

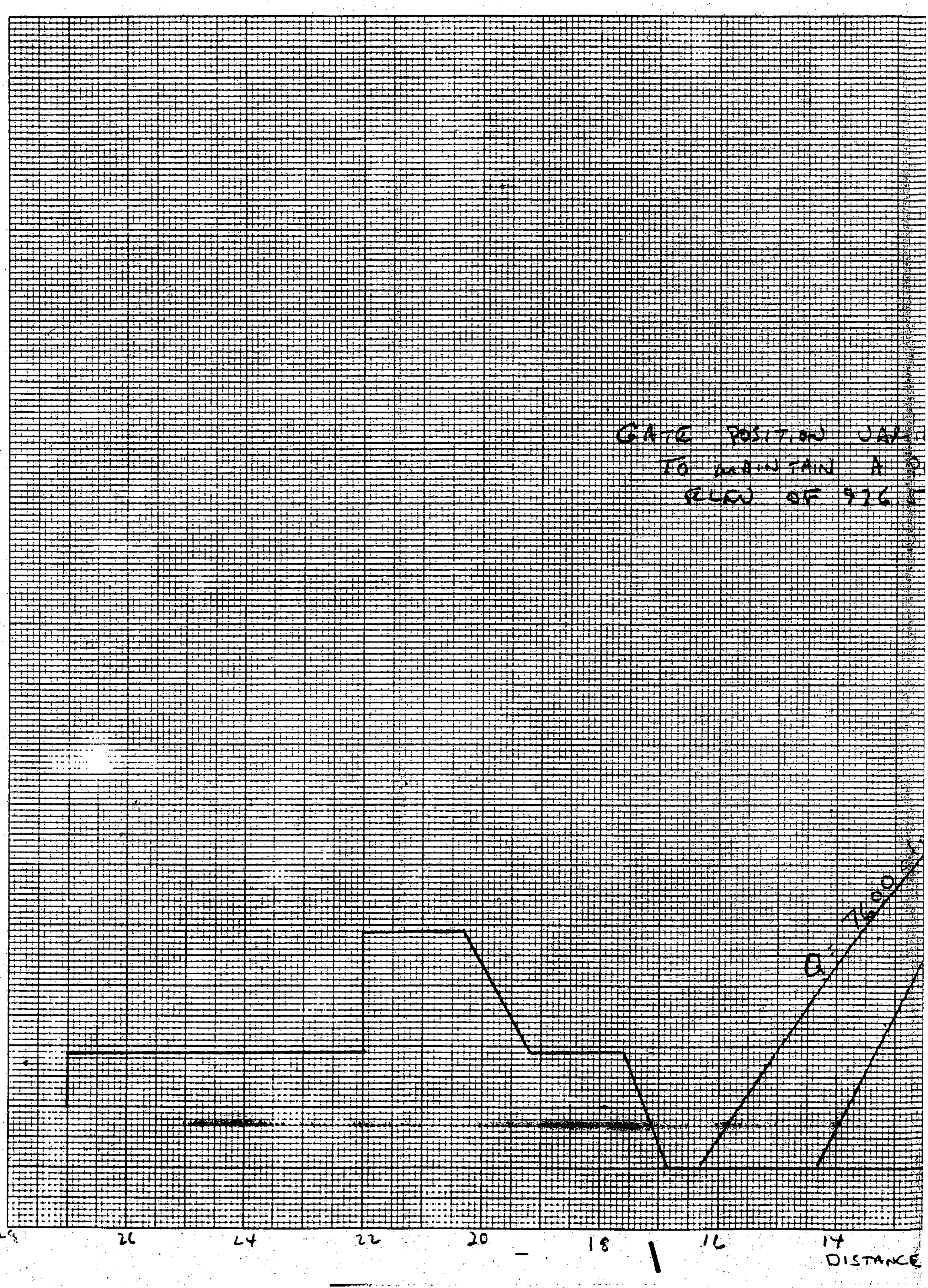


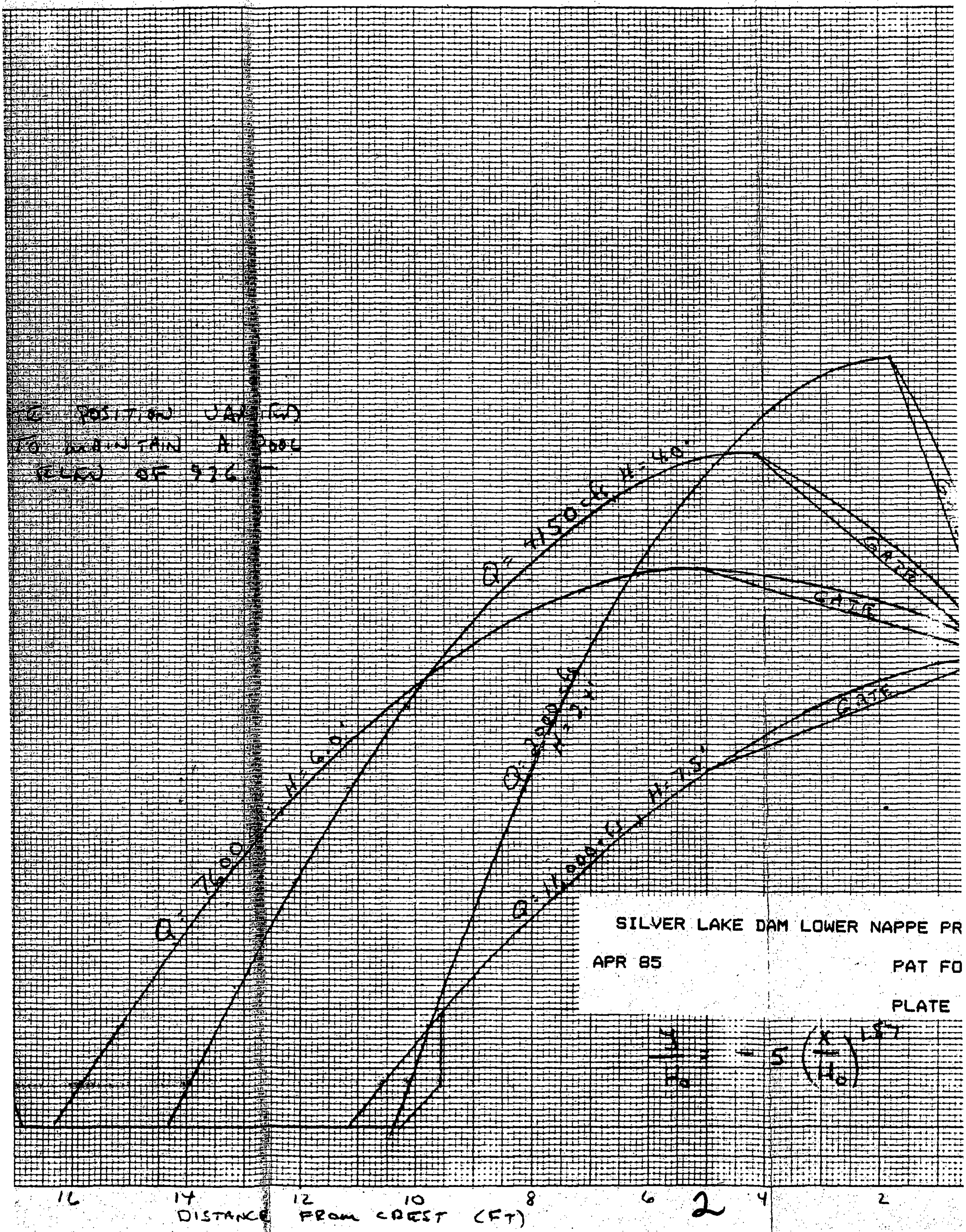
SILVER LAKE DAM RATING CURVES
AND
REQUIRED TAILWATER

PROPOSED CONDITIONS WITH PROPOSED
OPERATING PLAN

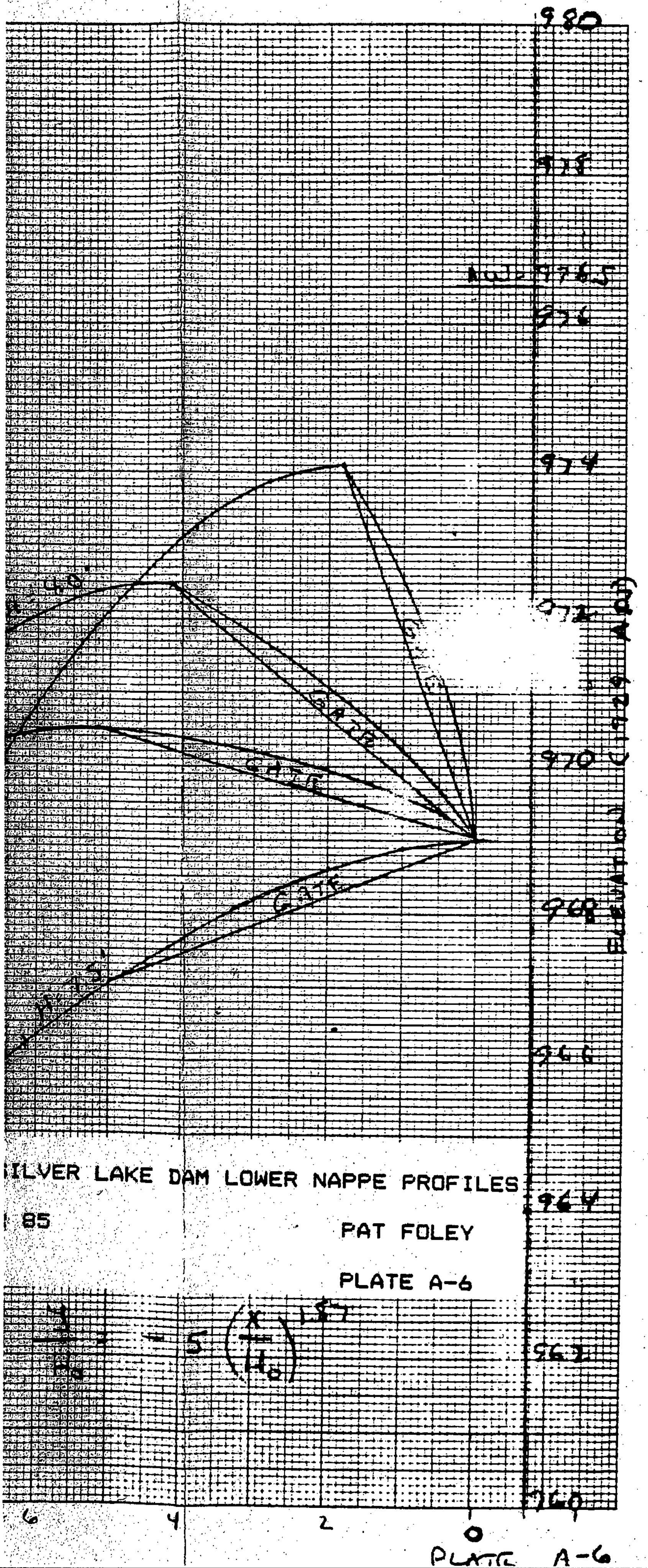
APR 85 PAT FOLEY

PLATE A-5


GATE POSITION
TO MAINTAIN A
FLOW OF 976
Q 7600
26
24
22
20
18
16
14
DISTANCE



POSITION VARIED TO MAINTAIN A POOL ELEV OF 976±
Q=4150 cfs H=4.0'
Q=7600 cfs H=6.0'
Q=2900 cfs H=3.3'
Q=11000 cfs H=7.5'
GATE
GATE
GATE
SILVER LAKE DAM LOWER NAPPE PR
APR 85
PAT FO
PLATE
$\frac{y}{H_o} = -.5\left(\frac{x}{H_o}\right)^{1.85}$
16
14
12
10
8
6
4
2
DISTANCE FROM CREST (FT)
2



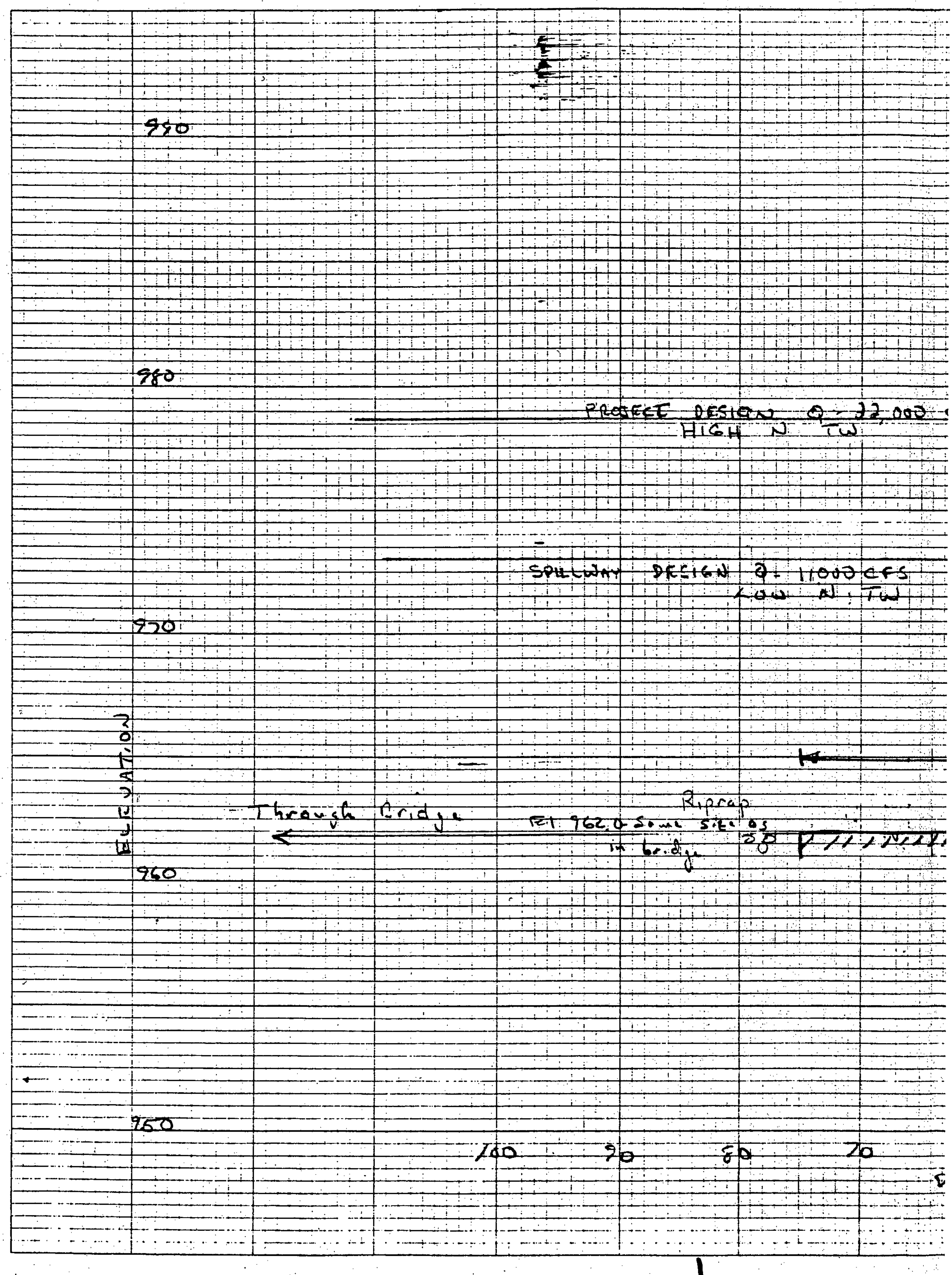
SILVER LAKE DAM LOWER NAPPE PROFILES

85

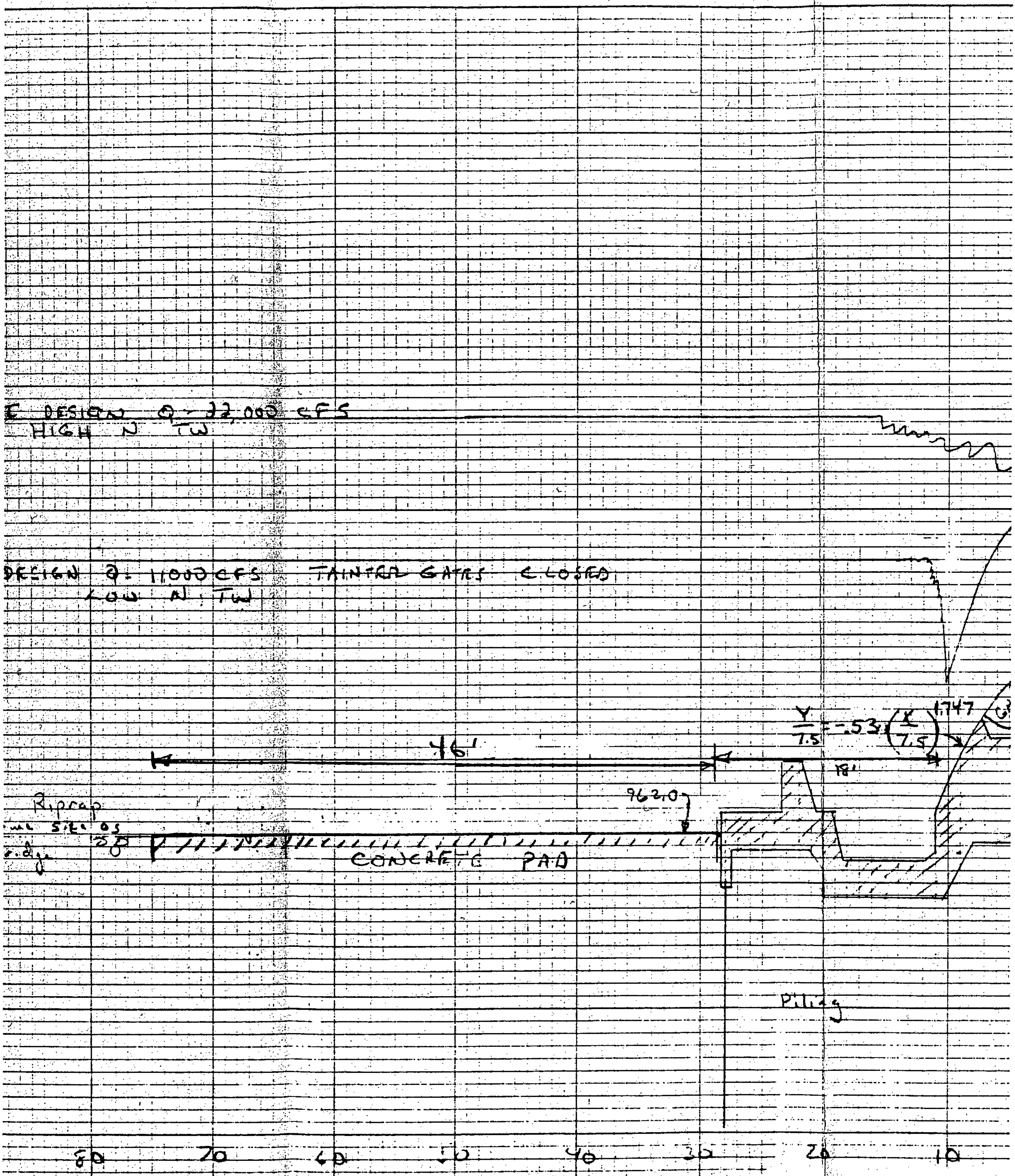
PAT FOLEY

PLATE A-6

PLATE A-6

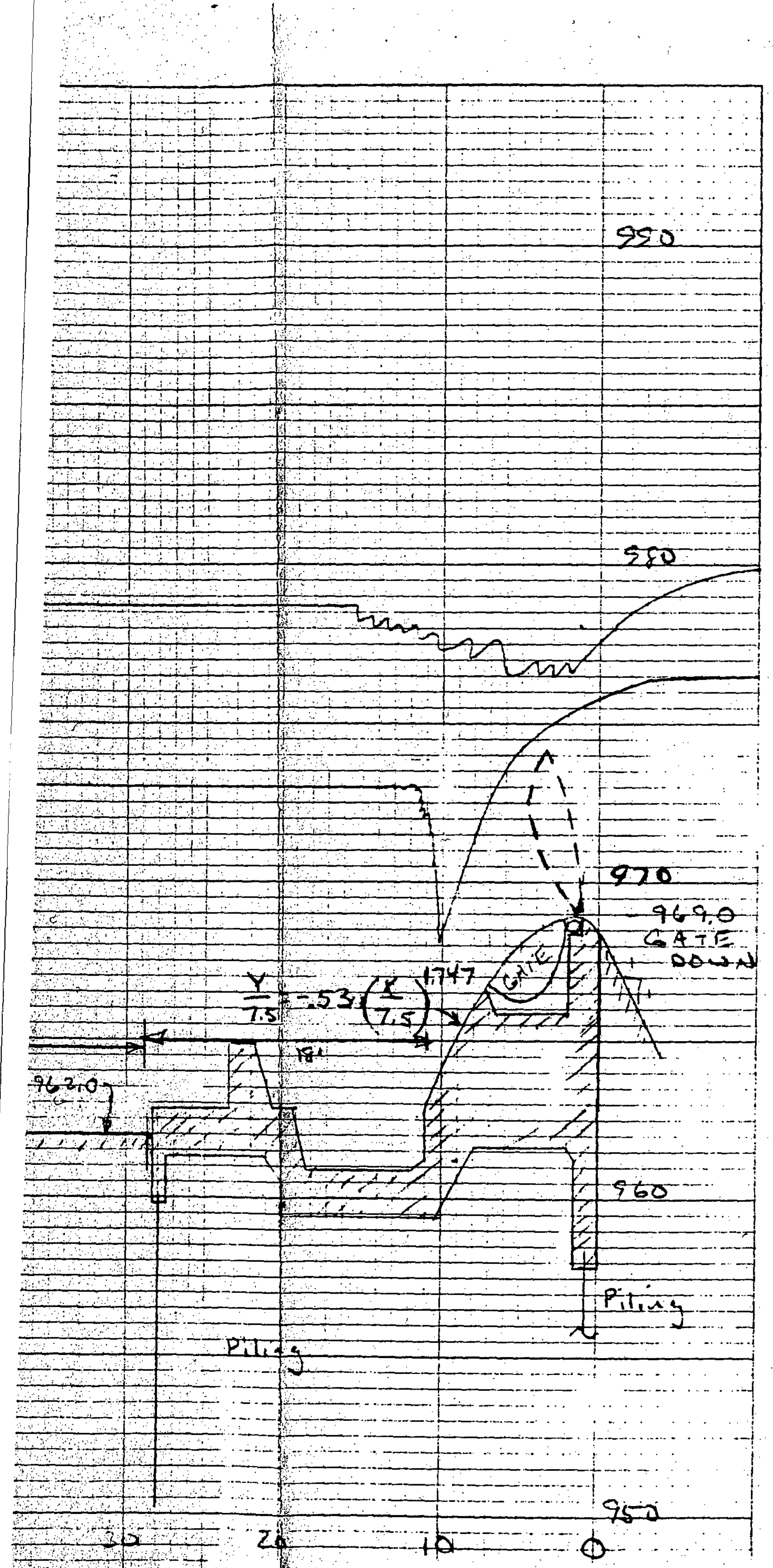

990
980
PROJECT DESIGN Q - 22,000
HIGH N TW
SPILLWAY DESIGN Q - 11000 CFS
LOW N TW
970
ELEVATION
Through Bridge
Riprap
El 962.0 Same size as
in bridge
960
950
100
90
80
70

1



SILVER LAKE DAM

APR 85



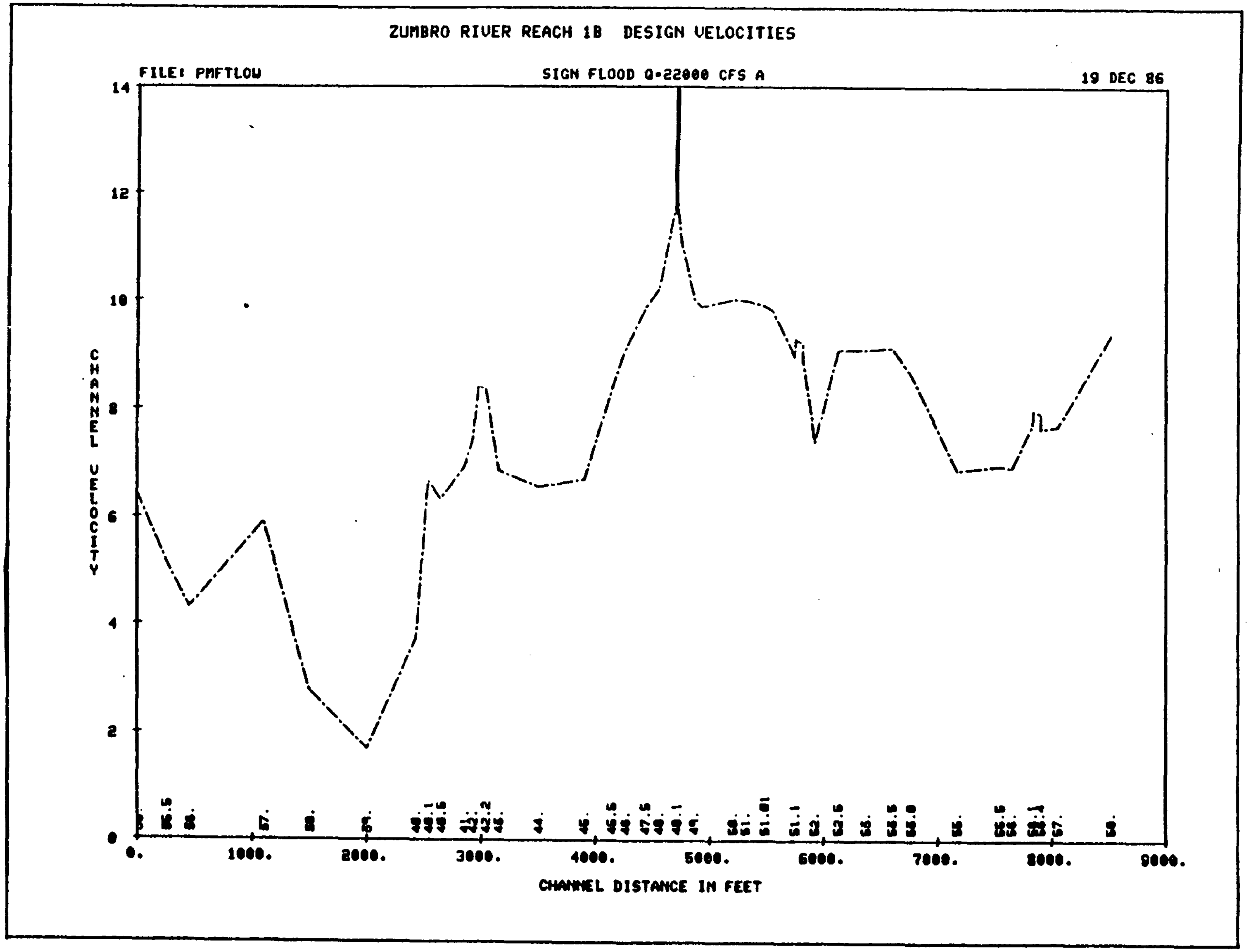
SILVER LAKE DAM PROPOSED SECTION

APR 85

PAT FOLEY

PLATE A-7

3



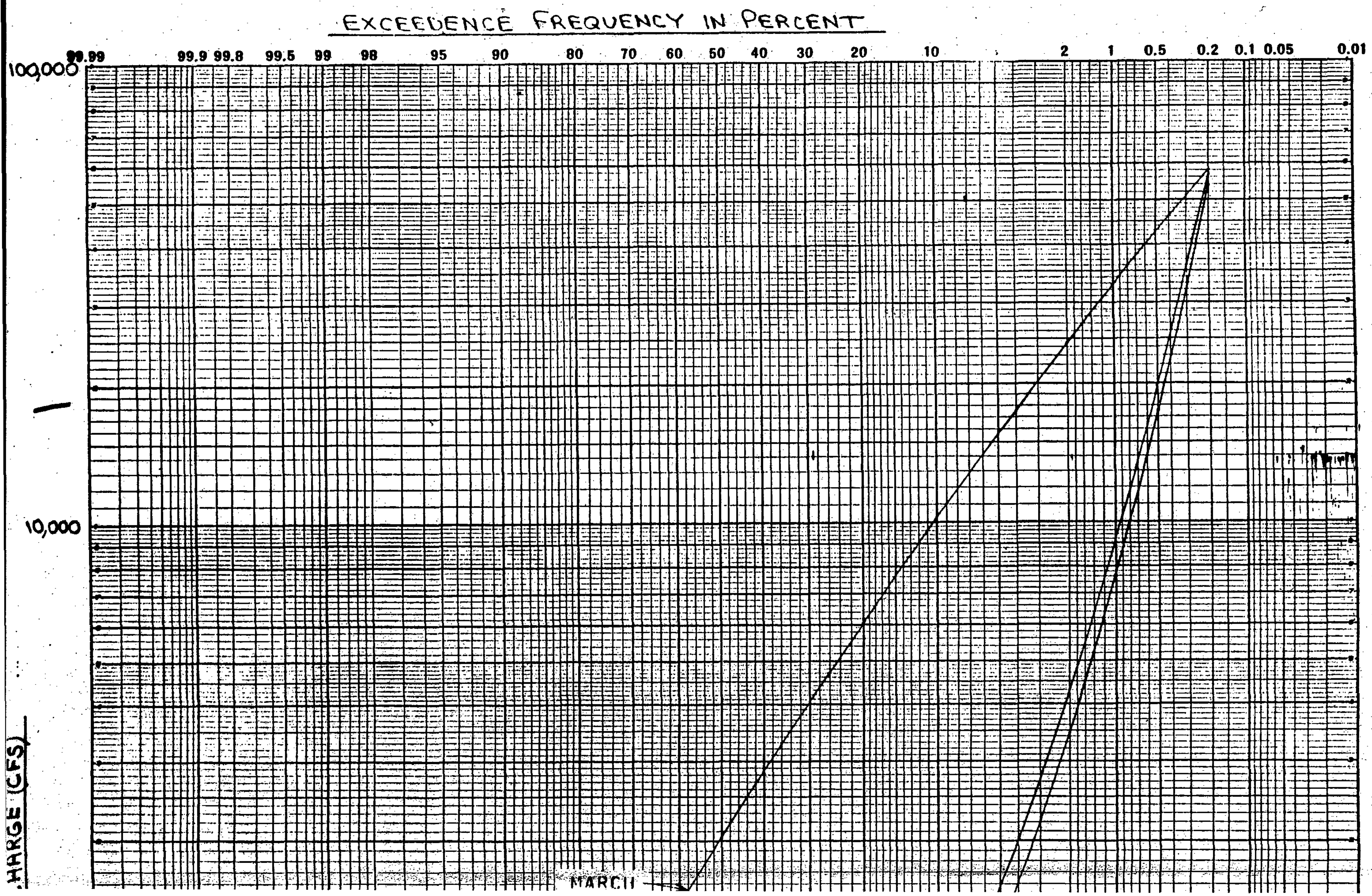
PROPOSED CONDITIONS CHANNEL VELOCITIES

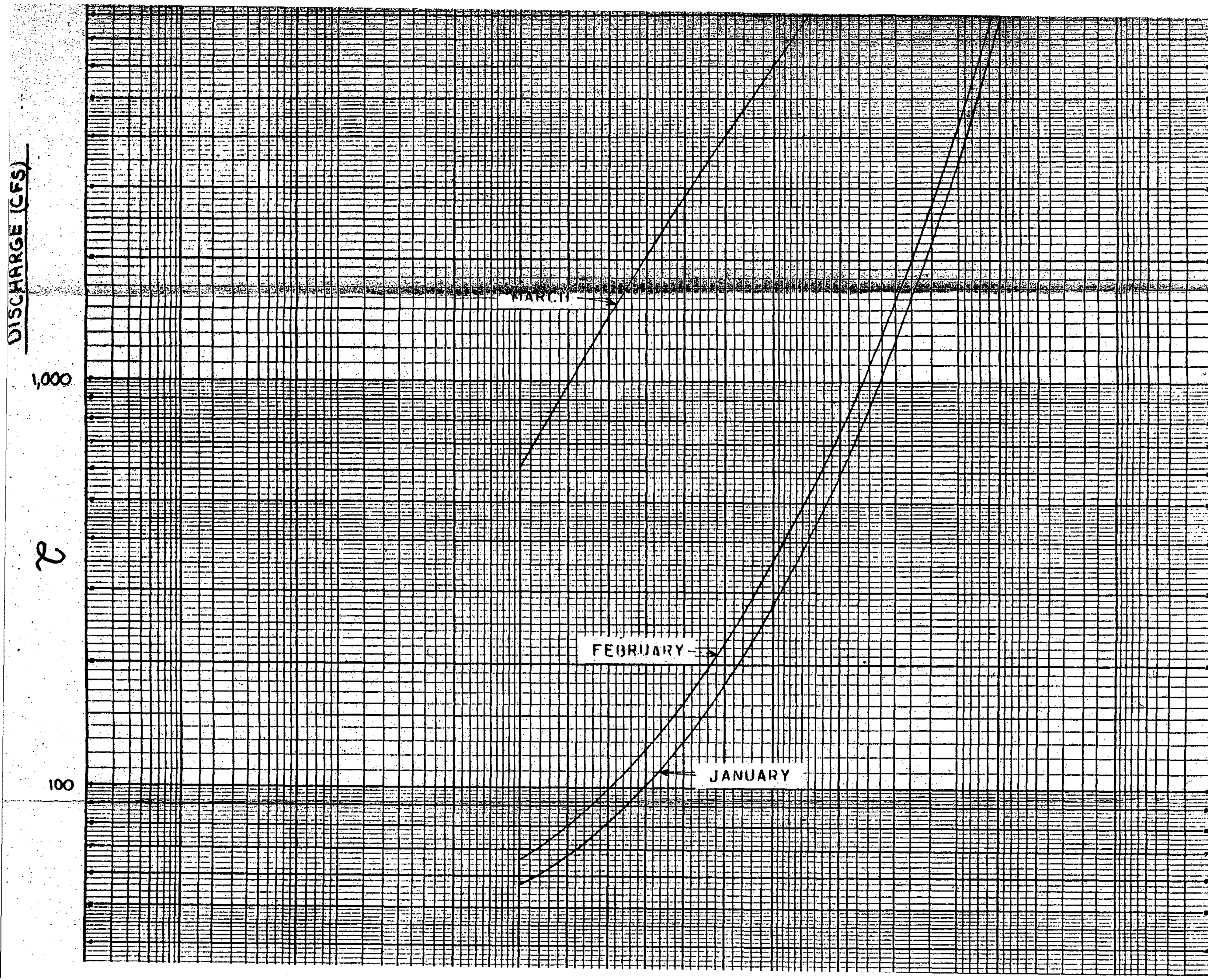
DEC 86

PAT FOLEY

PLATE A-8

PLATE A-8


EXCEEDENCE FREQUENCY IN PERCENT
99.99
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
2
1
0.5
0.2
0.1
0.05
0.01
100,000
10,000
.HARGE (CFS)
MARCH


DISCHARGE (CFS)
1,000
100
MARCH
FEBRUARY
JANUARY
2

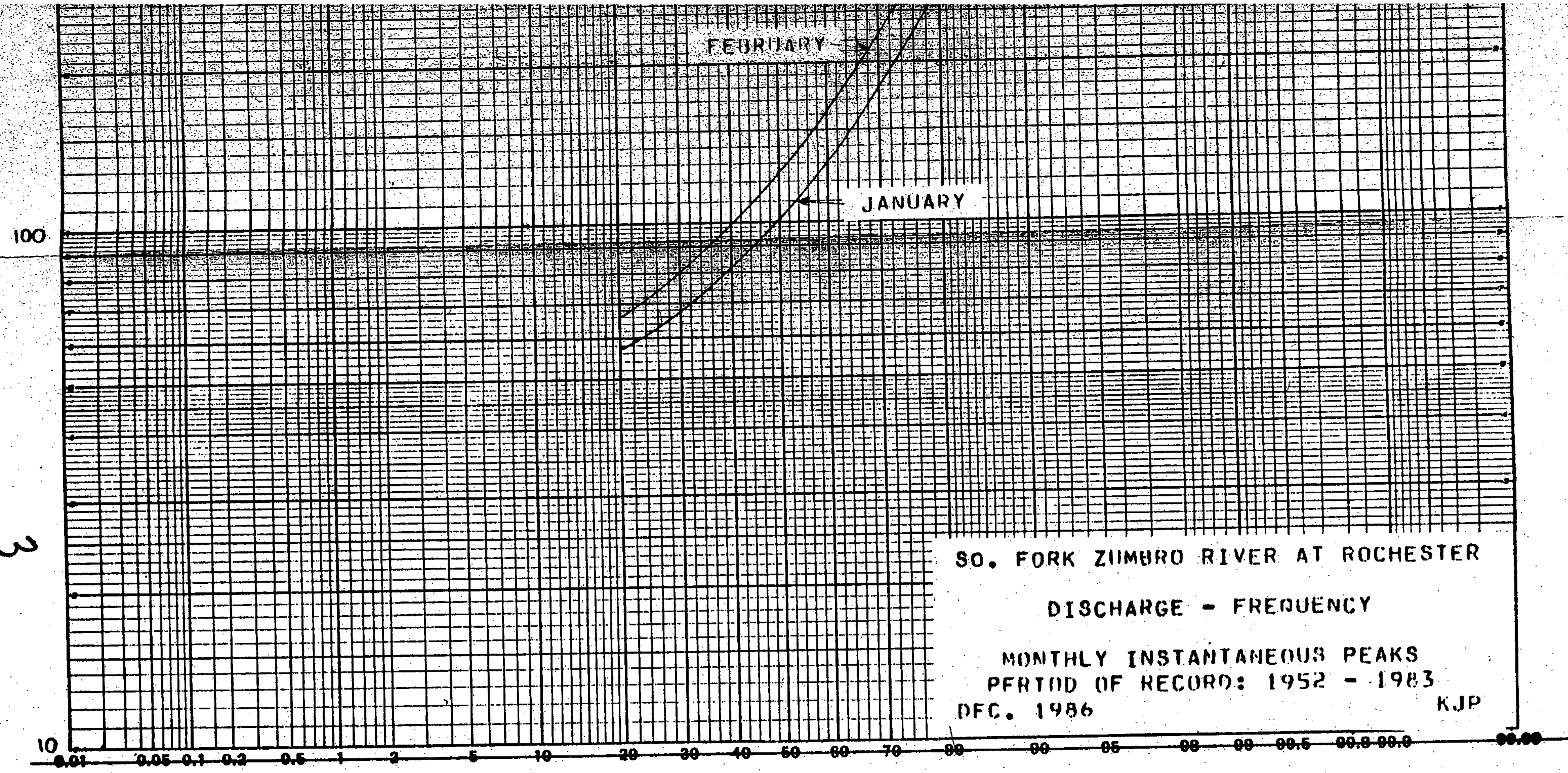
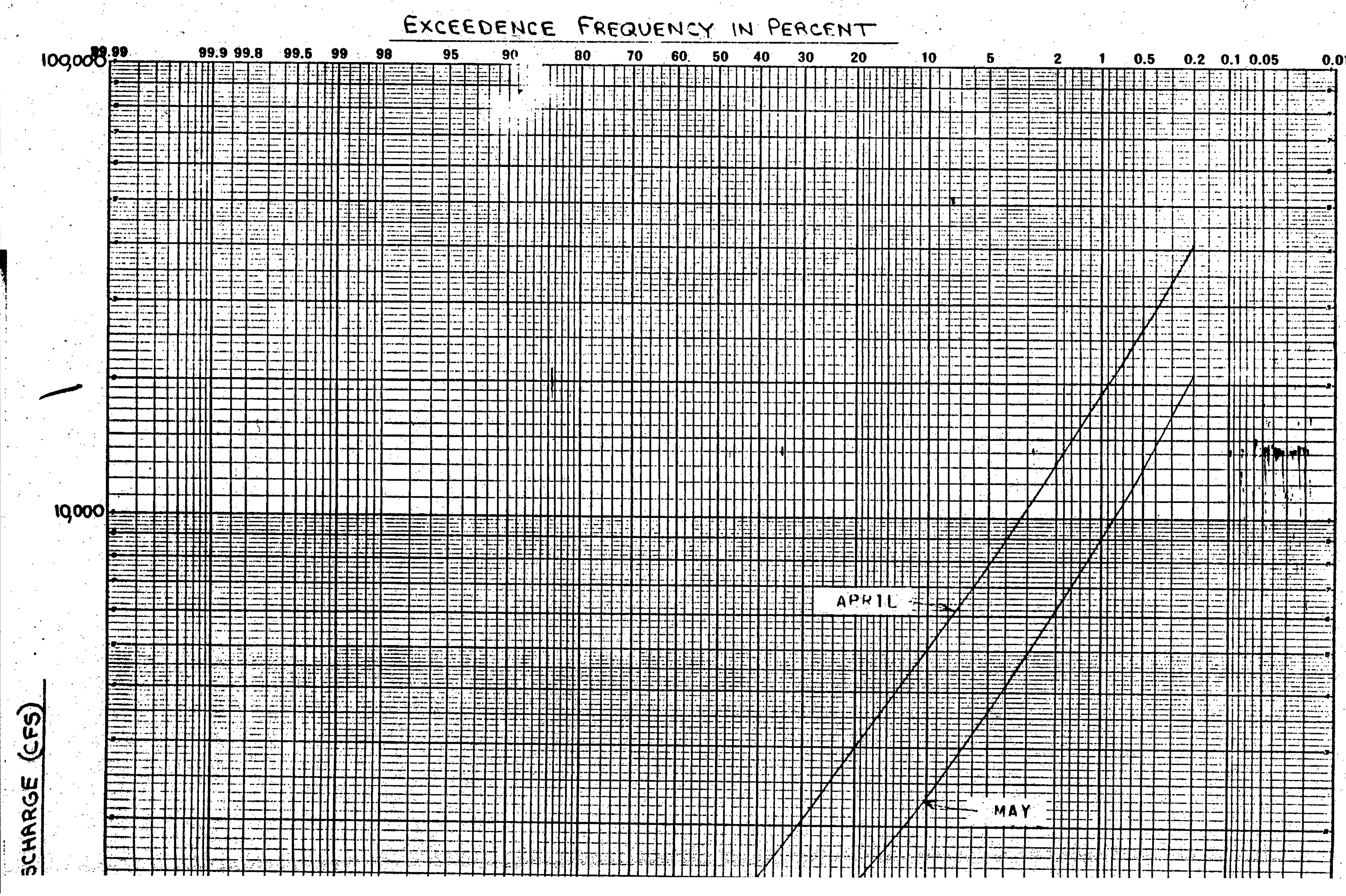
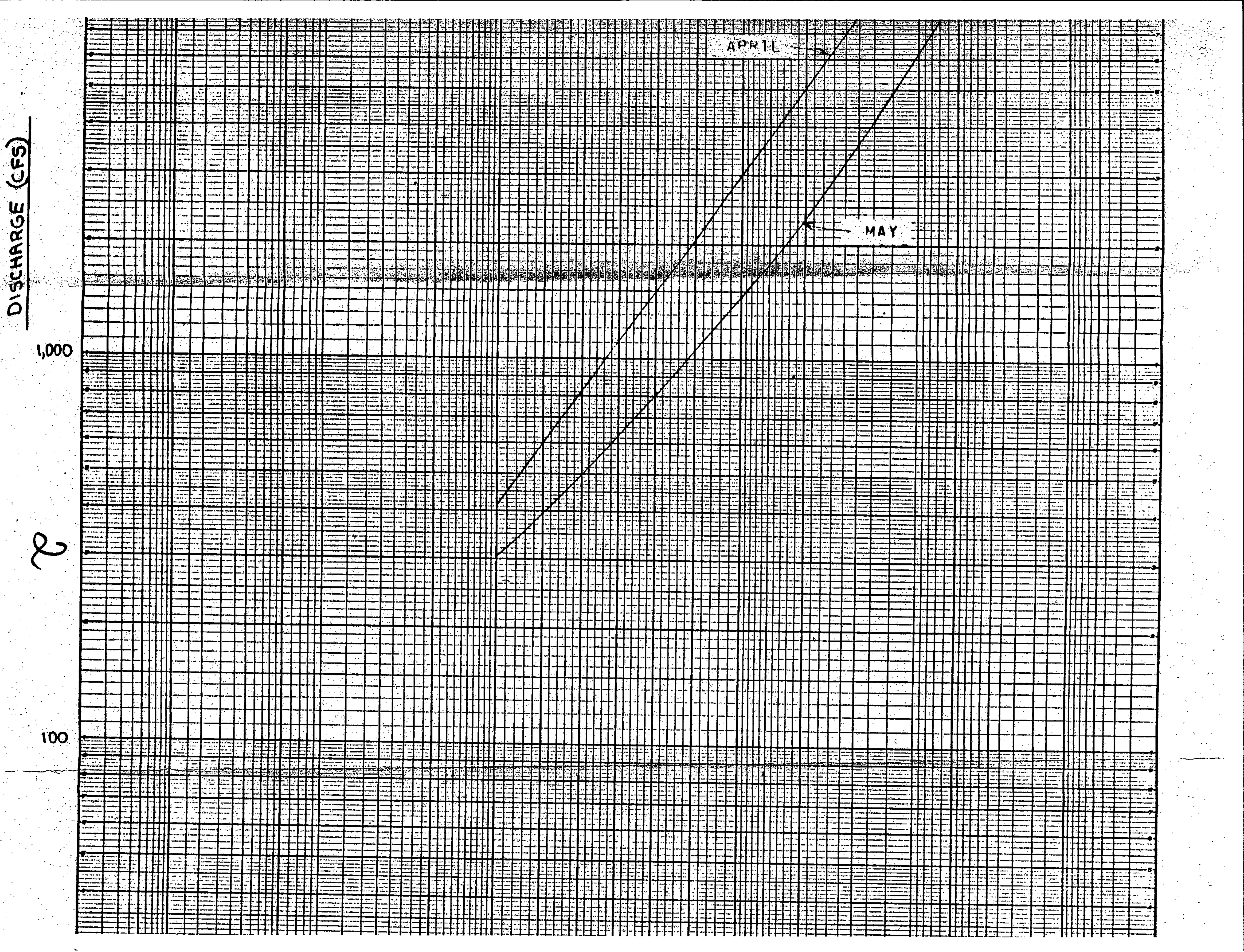

FEBRUARY
JANUARY
100
10
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.99
SO. FORK ZUMBRO RIVER AT ROCHESTER
DISCHARGE - FREQUENCY
MONTHLY INSTANTANEOUS PEAKS
PERIOD OF RECORD: 1952 - 1983
DEC. 1986
KJP

PLATE A-9

PROBABILITY - FOUR 3½ INCH LOGARITHMIC CYCLES. Y4 211 HG CODEX Graph Paper DIRECT FROM CODEX BOOK CO., NORWOOD, MASS. 02062 PRINTED IN U.S.A.





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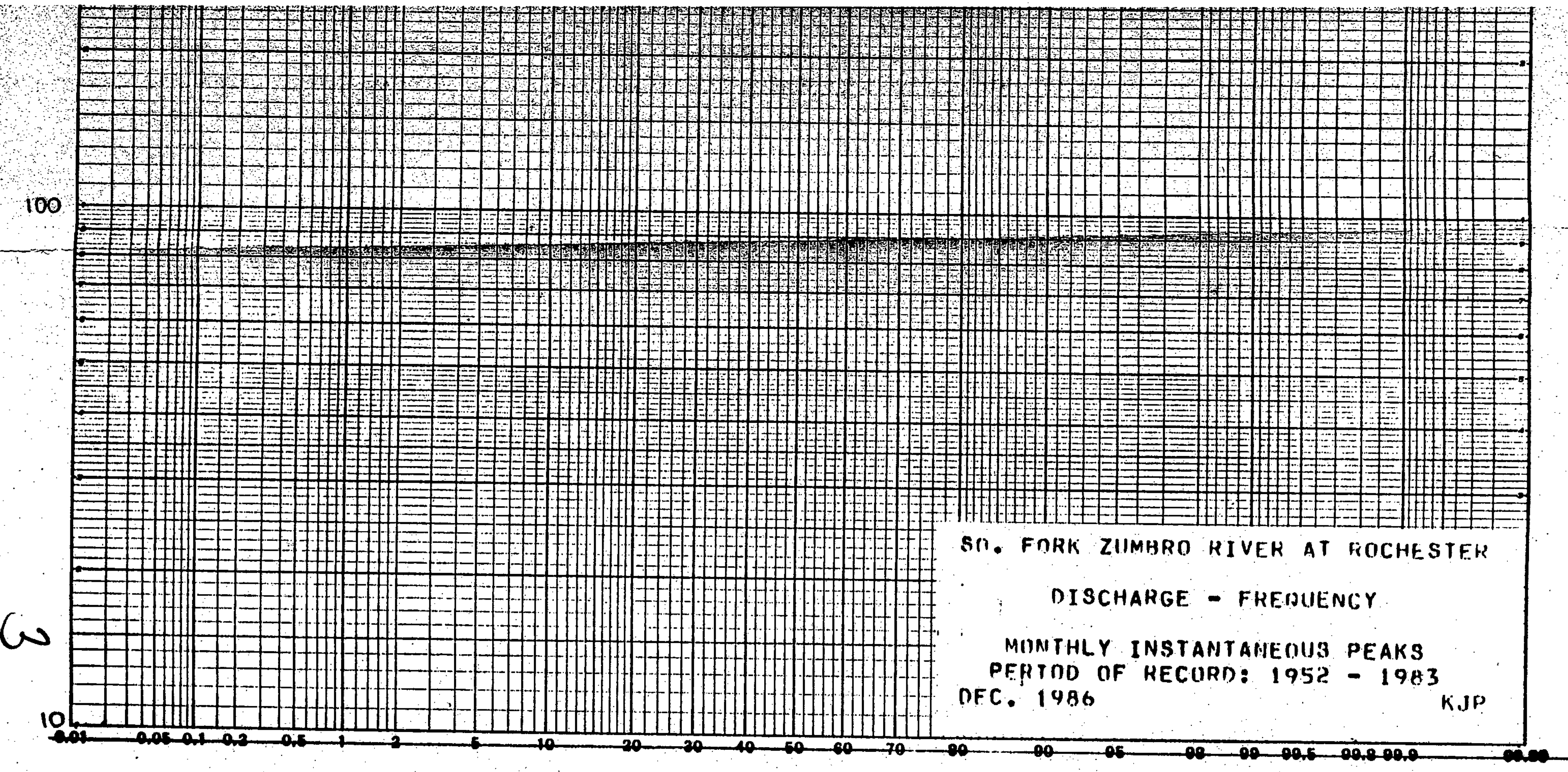

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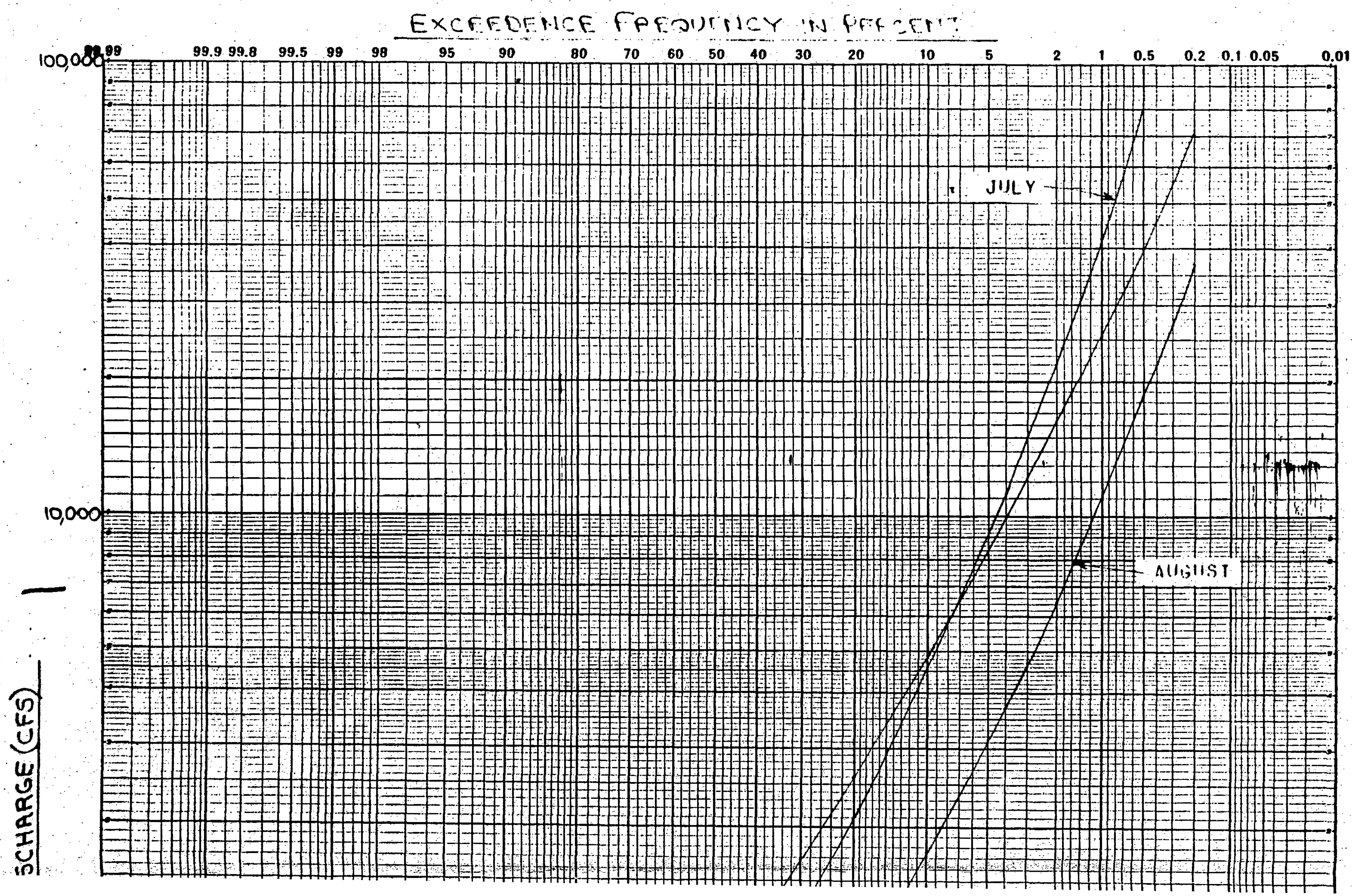
99.9
99.99
SO. FORK ZUMBRO RIVER AT ROCHESTER
DISCHARGE - FREQUENCY
MONTHLY INSTANTANEOUS PEAKS
PERIOD OF RECORD: 1952 - 1983
DEC. 1986
KJP

PLATE A-10

PROBABILITY • FOUR 3½ INCH LOGARITHMIC CYCLES. Y4 211 HG CODEX Graph Paper DIRECT FROM CODEX BOOK CO., NORWOOD, MASS. 02062 PRINTED IN U.S.A.



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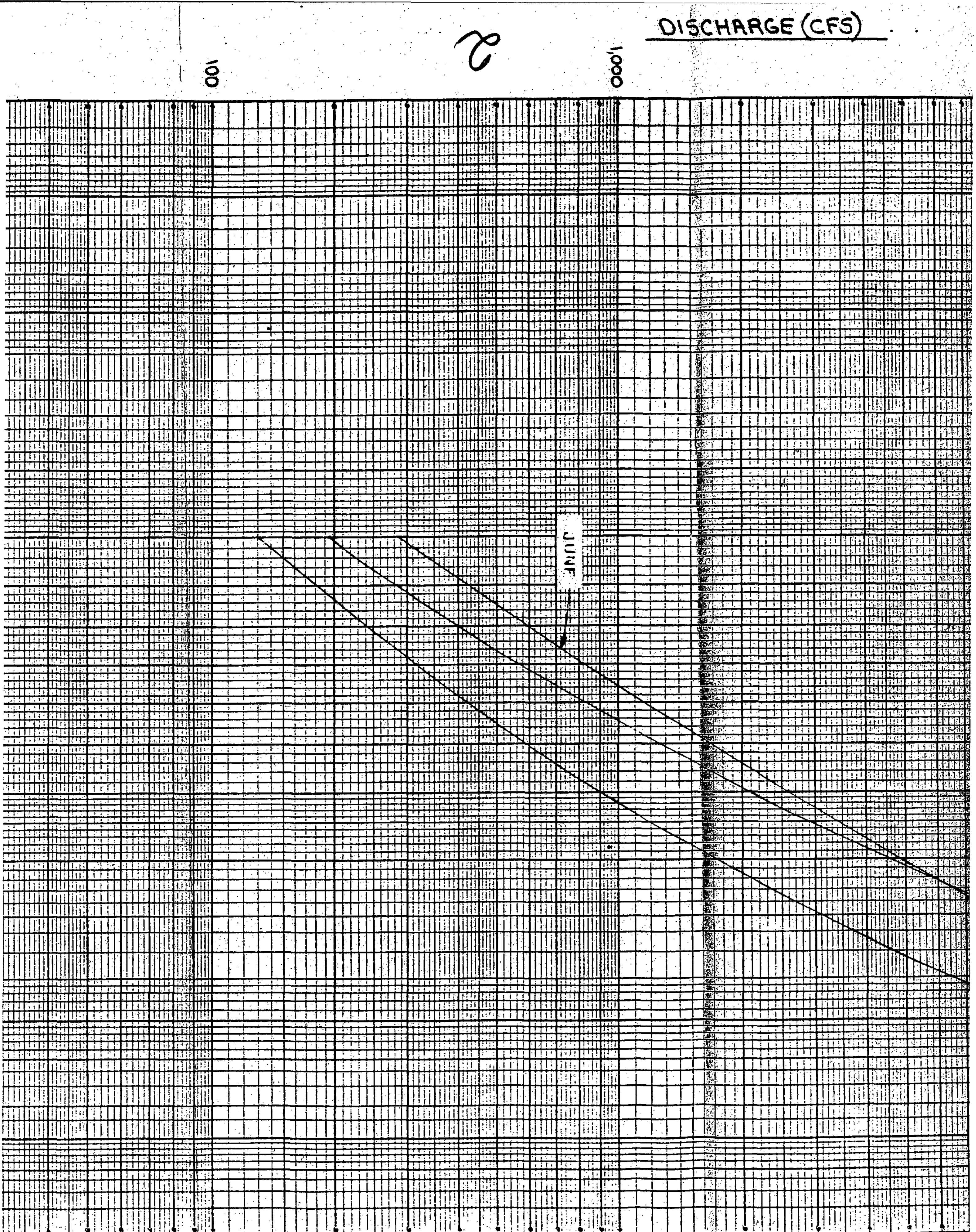

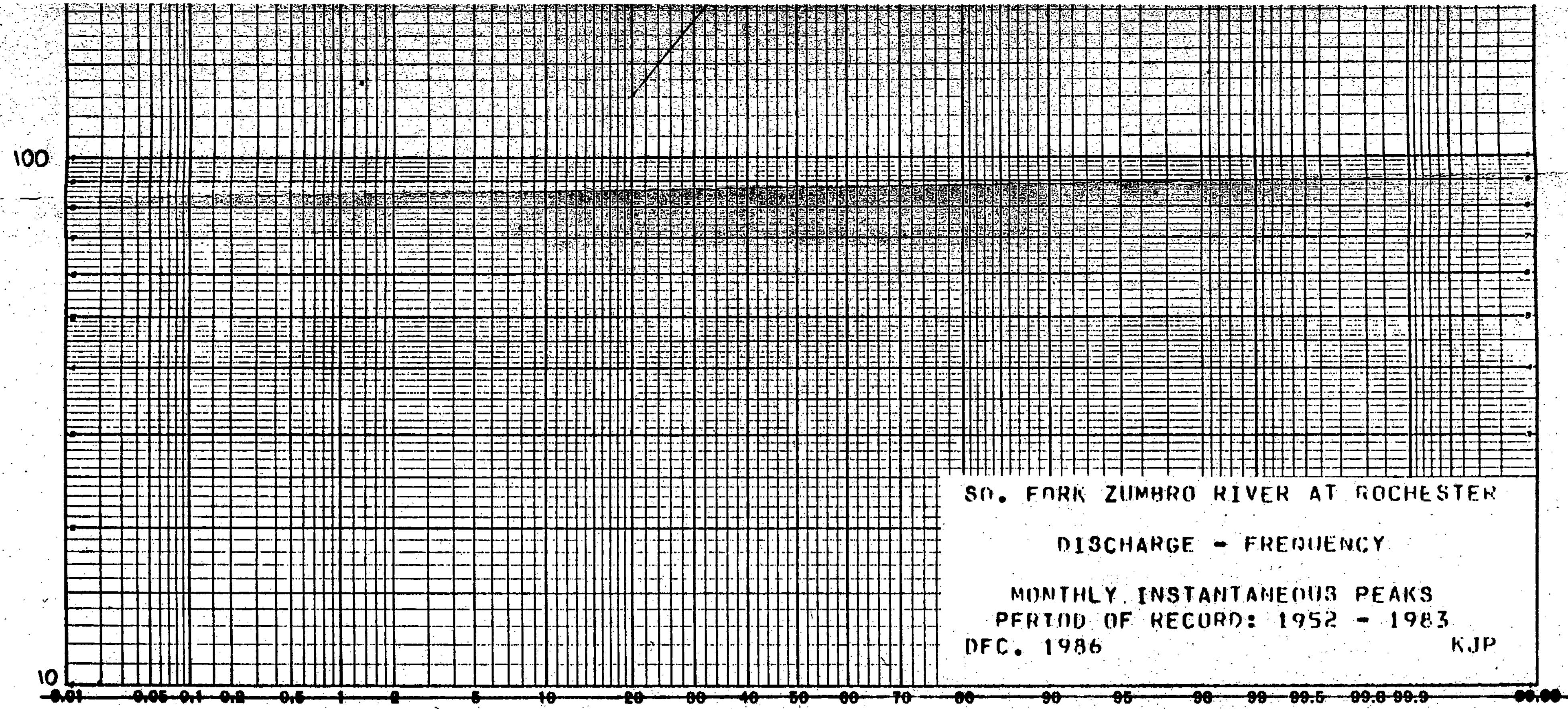
SO. FORK ZUMBRO RIVER AT ROCHESTER
DISCHARGE - FREQUENCY
MONTHLY INSTANTANEOUS PEAKS
PERIOD OF RECORD: 1952 - 1983
DEC. 1986
KJP
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PLATE A-11

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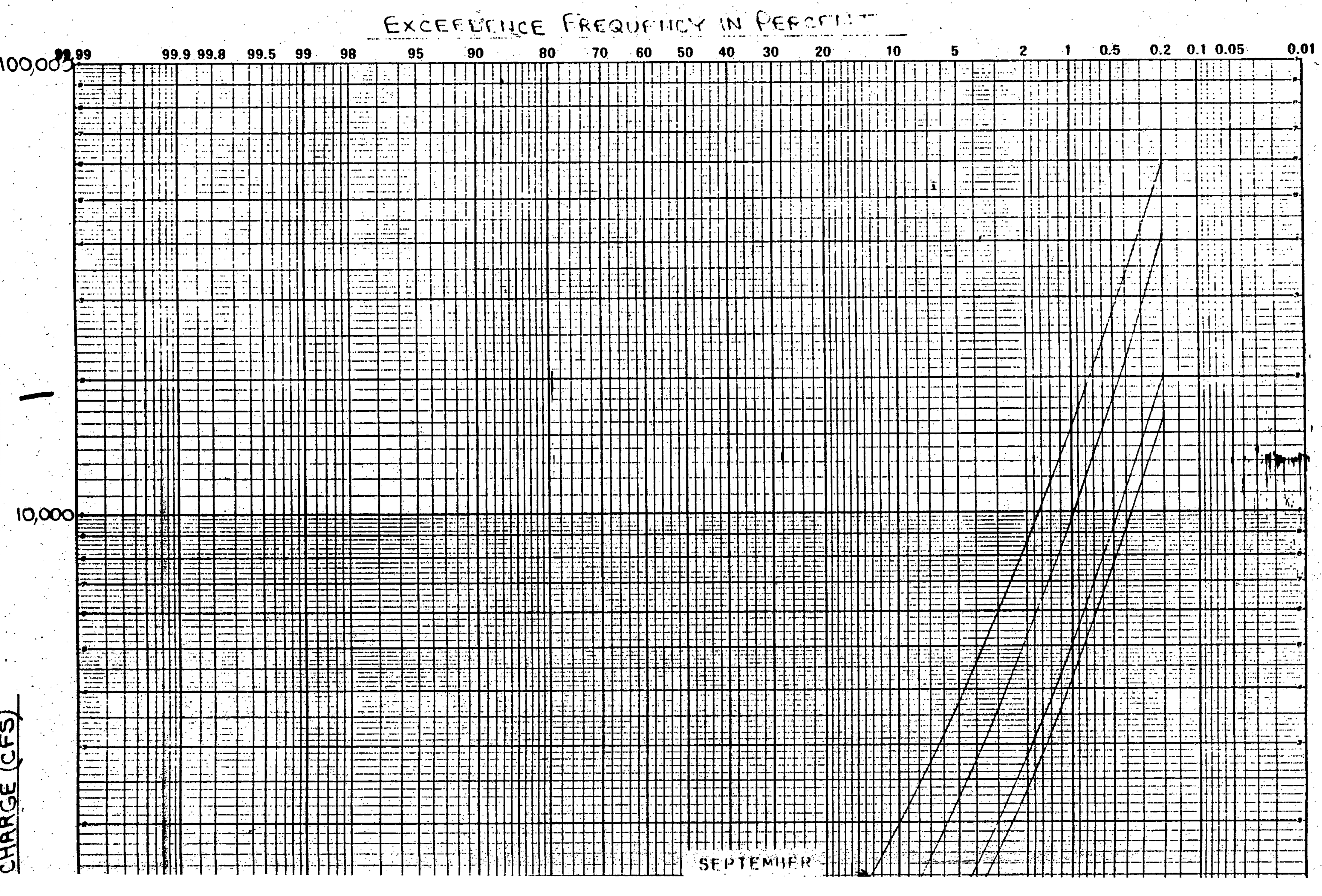

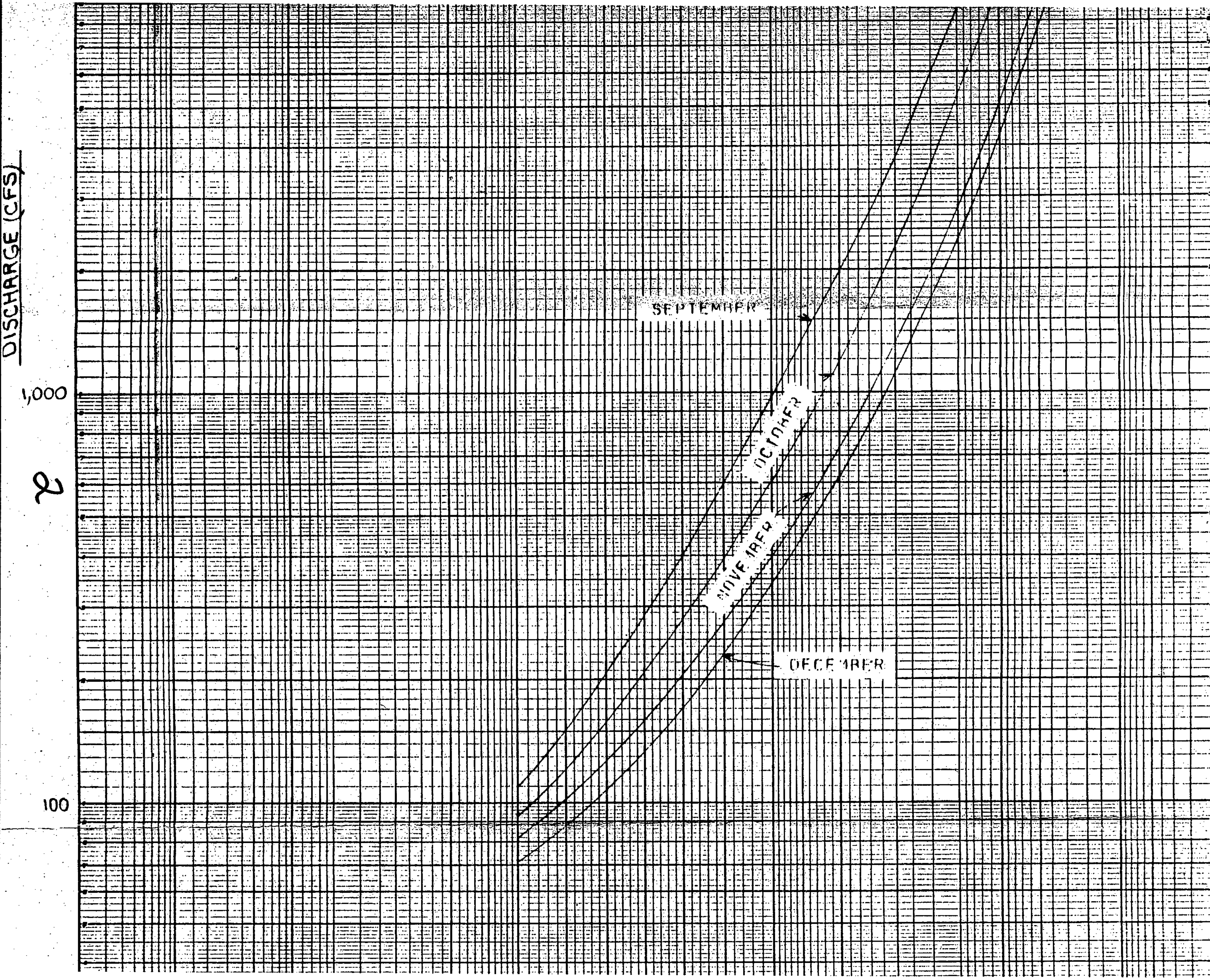
DISCHARGE (CFS)
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SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
2

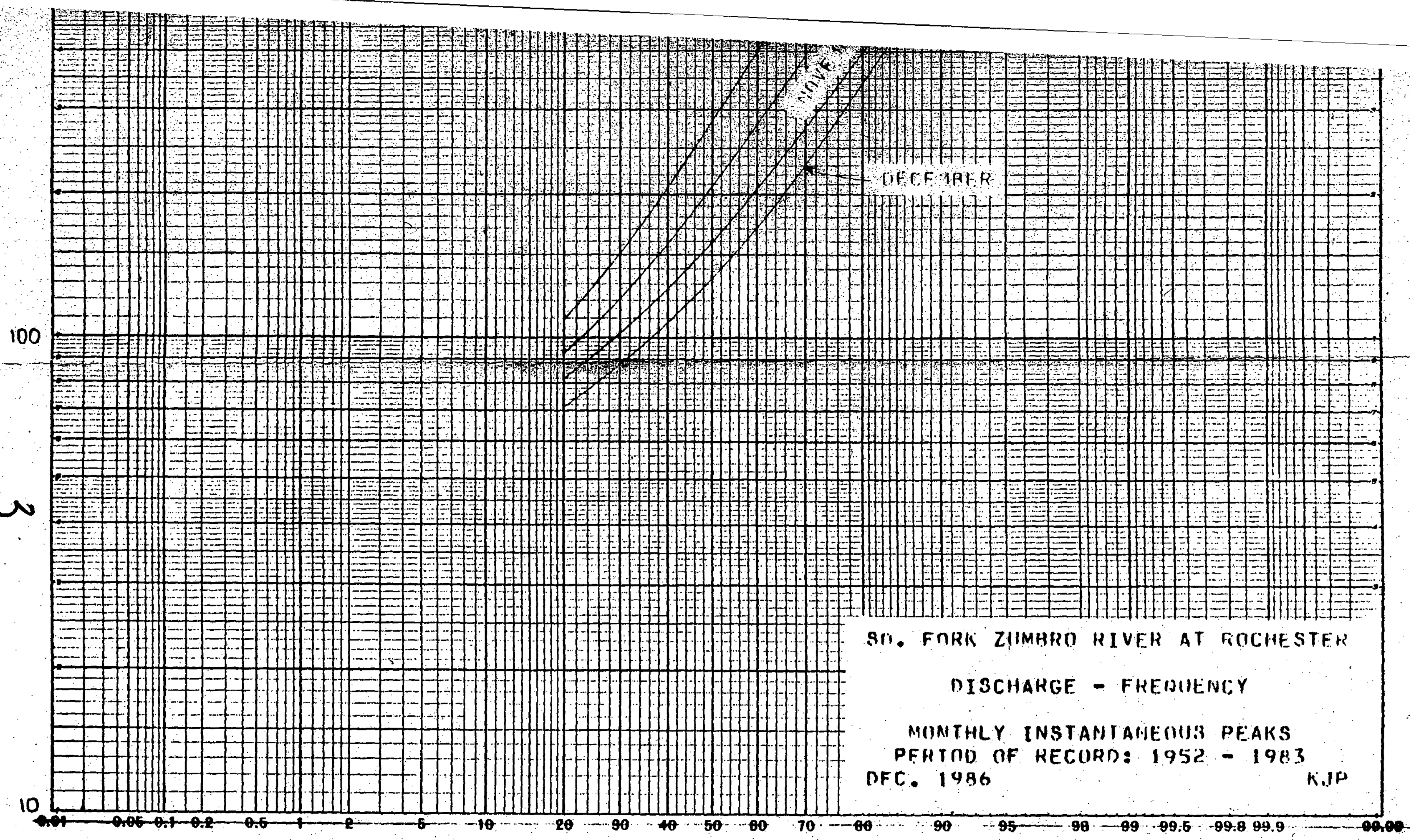
NOVE
DECEMBER
SO. FORK ZUMBRO RIVER AT ROCHESTER
DISCHARGE - FREQUENCY
MONTHLY INSTANTANEOUS PEAKS
PERIOD OF RECORD: 1952 - 1983
DEC. 1986
KJP
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PLATE A-12

APPENDIX B

GEOTECHNICAL DESIGN

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

DESIGN MEMORANDUM NO. 2
FEATURE PHASE 1B
FOR
FLOOD CONTROL

SOUTH FORK ZUMBRO RIVER WATERSHED

APPENDIX B
GEOLOGY AND GEOTECHNICAL

TABLE OF CONTENTS

TABLES

PLATES

PLATES (CONTINUED)

ADENDA

ROCHESTER
APPENDIX B
GEOLOGY AND GEOTECHNICAL

1. GENERAL

In the GDM, the Rochester Flood Control Project was separated into four general reaches:

1) Lower Zumbro, Sta-4+40 to 126+75.

2) Upper Zumbro, Sta-126+75-317+50.

3) Cascade Creek.

4) Bear Creek.

Subsequent refinement in the subdivision of project reaches has resulted in the limits of Reach 1B extending from the N. Broadway Bridge, Sta 126+00 to the 3rd Ave SE bridge Sta 205+67. The reach also includes the very downstream most limits of Bear Creek, from its confluence with the Zumbro, Sta 0+00, to Sta 6+50 at the 4th St. SE bridge. The primary Reach 1B features include:

1) Modifications to Silver Lake Dam, including

    a. Sheet pile cut off walls.

    b. Foundation Soil Anchors.

    c. New gates and mechanical equipment.

    d. Concrete repairs/replacement.

    e. Downstream channel protection, etc.

2) Channel dredging through Silver Lake from Sta 127+00 to about Sta 152+00, and

3) Channel deepening, slope protection, channel wall modification and new construction, and bridge abutment, pier and wing wall modifications from Sta 152+00 to Sta 205+67 on the Zumbro River and on Bear Creek from Sta 0+00 to 6+50.

TOPOGRAPHY AND GEOLOGY

2. A discussion of the general topography of the project area and contributing drainage basin is presented to provide background for understanding the topographic setting as it relates to the flood hazard at the City of Rochester and how specific foundation conditions relate to the total geologic environment.

3. The City of Rochester is located in a maturely dissected till plain of the Central Lowlands physiographic province. The South Fork Zumbro River is joined by Bear Creek, Silver Creek and Cascade Creek within the corporate limits of the city. These streams have fairly steep gradients and radiate from Rochester to the east, south and west in a well-developed dendritic pattern which allows rapid drainage from the entire basin area of 304 square miles from Rochester. As the main streams are joined by numerous tributaries, their valleys become increasingly wider and deeper until they are cut more than 200 feet below the surrounding uplands. The floodplain of the South Fork + Zumbro River varies from elevation 960 to 1010 within the project limits. Upstream from the mouth of Cascade Creek, this floodplain coalesces with those of the tributaries. Throughout most of the project area and a short distance upstream, the floodplains grade into the upland through gentle terraces and slopes. Sharp delineation of individual floodplains is, therefore, difficult. Downstream from the mouth of Cascade Creek, however, the Zumbro River valley is narrower with sharply defined topographic features. In the city the channels are stabilized with stone protection and retaining walls, and some reaches are bordered by commercial and domestic structures. In addition, numerous bridges create obstructions to flow in the channels, and two dams on the Zumbro River between the mouths of Cascade and Bear Creeks have raised the natural water level in that area. The mature development of the basin drainage and the merging floodplains provide a natural environment for severe flood potential which is aggravated by the numerous channel obstructions.

4. The uplands in the basin headwaters and adjacent to Rochester are mantled by glacial drift that is older than Late Wisconsin (Mankato). The thickness of the drift is not known but is estimated to average less than 25 feet. A thin veneer of silty loess covers the drift in the extreme northern and southern portions of the basin above Rochester. The drift is underlain by Devonian and Ordovocian shales, dolomites and limestones, and sandstones.

5. The South Fork Zumbro River and lower portions of the tributary valleys were at one time eroded to depths up to 60 feet below the present floodplains and subsequently backfilled to their present levels. The deepest scour probably occurred during the Glacial Epoch when the discharge was greater and the regional base level of erosion was lower. The valley fill under the project area is primarily sand and gravel which is capped by a mantle of silty sand, silt and clay of varying thicknesses on the floodplains.

6. Bedrock underlying the project area is the Prairie du Chien Group,

which is composed in descending order of thin bedded dolomite of the Willow River Member of the Shakopee Formation, sandstone of the Root Valley Member and thin to thick bedded dolomite of the Oneota Formation. Friable sandstone of the St. Peter Formation overlies the Shakopee Formation and is exposed at numerous locations in the vicinity of Rochester below elevation 1100. The Prairie du Chien Group is underlain by thick units of Cambrian and Precambrian sandstones with lesser amounts of dolomite and shale which are well below the influence of the proposed construction.

7. The regional dip is to the southwest at about ten feet per mile. Within the project area, however, the beds are essentially horizontal according to the most recent available publication. Unpublished information obtained from the Minnesota Geological Survey indicates that a complex system of faults striking northwest and northeast may exist in and around Rochester. If such faults exist, they are inactive and will neither impact nor be impacted by the project.

8. Ground water discharges into the streams in the region. Within the narrow limits of the proposed construction activity, however, the water table is essentially the same as the river level. Any change in the river level will, therefore, result in a corresponding change in the nearby water table.

9. The courses of the modern streams through Rochester do not follow older channels known from limited subsurface data to have been cut much deeper into the bedrock. The South Fork Zumbro River and Bear Creek flow on thin-bedded dolomite for several hundred feet a short distance upstream from their confluence, and Cascade Creek flows on the same type bedrock a short distance above its mouth. These bedrock channel bottoms are the effective base levels of erosion for the upstream subbasins and from a project perspective are considered the most important factors contributing to the contrast in valley form between the narrow, well-defined valley downstream from Rochester and the broad valleys with their subdued features and meandering channels upstream. Although the change in valley form may also be attributed to other factors such as lateral erosion of the friable St. Peter Formation during the Pleistocene, sedimentation in ephermeral lakes or valley filling due to the greater load capacities of the numerous tributaries, the bedrock base-level concept is the only one that is important in the consideration of impacts created by the project. Channel deepening will create a change in base level that will result in headward erosion on all streams until a new equilibrium is established if effective control structures are not installed.

ENGINEERING GEOLOGY

10. The most important aspects of the site geology directly related to the engineering of the project are the types and distribution patterns of materials underlying the channels and immediately adjacent floodplains of the South Fork Zumbro River, Bear Creek and Cascade Creek. Although the project covers considerable distance that is

characterized by variations in the form and depth to bedrock, the foundation materials consist essentially of granular overburden resting on thin-bedded dolomite. Moreover, the most significant variable is the depth to bedrock which determines how, in this simple geologic column, a given feature is to be founded. Profiles showing the top of bedrock along the proposed channel centerline are displayed on Plates 16 through 23 in the main report.

11. OVERBURDEN

Overburden in the project area is alluvial fill in the valleys of the South Fork Zumbro River and its tributaries. It consists primarily of clean to slightly silty sands and gravels mantled by recent floodplain deposits of silty sand, silt and clay, man-made fills also comprise a portion of the overburden. The materials are generally medium dense, free-draining and easily eroded by running water. Although the general character of the overburden persists throughout the project, local variations typical of stream-valley sediments are evident.

12. BEDROCK

Bedrock to be considered in the engineering of the project is restricted to the Shakopee Formation of the Prairie du Chien Group. Although the Oneota Formation of the same group subcrops below the valley alluvium downstream from the mouth of Cascade Creek, it is too deeply buried to be of interest except that it may be the foundation for existing bridge piling. Field inspection of outcrops and limited data from core borings were used to develop general statements about the engineering properties of the Shakopee Formation. These properties, or characteristics, were used to develop design concepts presented in this report and are discussed in the following paragraphs.

13. ROCK TYPE

The Shakopee Formation represented within the influence of the project is a thin-bedded, moderately hard to hard dolomite. The rock is characteristically weathered and fractured at the surface and grades to solid, unweathered rock. Bedrock exposed along the existing channels shows some recession of softer seams. In general, however, the rock is surprisingly durable in spite of its fractured, blocky structure. Bedding planes form gently undulating surfaces with variations of 2 to 3 inches from a smooth plane. Rock permeability is high at the bedrock surface due to a high frequency of fractures. A low frequency of water loss in cored holes, however, suggests that rock permeability decreases rapidly with depth.

14. ROCK EXCAVATION

The results of a study of near surface rock characteristics are presented in paragraph 33. Based on that study and field inspection of outcrops, the bedrock is estimated to be rippable to an average depth of 4.5 feet with a D-9 dozer and mounted hydraulic No. 9 ripper.

Some rock will have to be loosened by blasting which is the most feasible method to remove rock in the quantity required. Blasting of rock at this project is an extremely sensitive operation due to the urban environment and proximity to structures. It must, therefore, be adequate to break the rock but not damage nearby structures nor create excessive concern among the population. Achieving these goals will require site calibration to determine charge weights and delay patterns, preconstruction inspection of structures, education of the population, rigidly enforced rules for the conduct of the blasting, and vibration and air-blast monitoring. As many as 200,000 short blast holes may be required, and charge weights per delay may be limited to less than 1/2 pound in much of the area. Individual blasts in some areas may be limited to only few delays to keep human response at a tolerable level. These factors combine to make a tedious and expensive operation that will require an aggressive public relations program.

15. SLOPE-FORMING CHARACTERISTICS AND DURABILITY

The bedrock can be excavated to and should retain almost any slope. Slopes formed by ripping will be rough with a probable variation of at least one foot from a neat line. Slopes steeper than 1V on 1H will have to be cut by methods other than ripping with a dozer. Soft seams are present in some areas and will allow the rock to erode unevenly. Where permanent retention of slopes steeper than 3H on 1V is critical, the slopes should be protected if an eventual loss of up to two feet of slope cannot be tolerated. Sculpturing the rock to close tolerances will require special treatment such as line drilling or lightly loaded smooth blasting. Smooth blasting with closely spaced, small diameter holes is preferred over preshearing because of the better control of overbreak at the tops of the holes in the thin-bedded and fractured rock to be preserved. Due to the uncertainty of success and additional expense of cutting, or sculpturing, rock to close tolerances, designs that require intricate rock excavation should be avoided if possible.

16. FOUNDATION QUALITY

The bedrock is adequate foundation for structures planned for the project. Loose, fractured rock at the bedrock surface should be removed, however, and a buffer of rock left between structures and rock slopes unless the rock slope is permanently protected to prevent deterioration.

17. ROCK EXCAVATION CLOSE TO EXISTING STRUCTURES

Project plans call for the excavation of bedrock to a steep face as close as possible to some existing bridge piers and retaining walls. Such excavation must be conducted in a manner that will not endanger the structures. The method recommended consists of placing the rock between a structure and the excavation line in compression with a row of rock bolts followed by excavation to grade a safe distance from the final excavation line. Excavation to the designated line should be

conducted by hand trimming or lightly loaded smooth blasting. The final rock face must be protected with a cover of concrete where subjected to frequent or continuous erosion such as around a bridge pier or elsewhere if the quality of the completed rock face is too poor for long-term durability.

18. CHARACTER OF EXCAVATED ROCK

Rock excavated for widening and deepening the stream channels is expected to be slabby and have an average thickness of less than 6 inches. This thin, slabby character will limit its use on the project without additional processing.

19. ROCK PERMEABILITY

The permeability of the bedrock is important for this project only as it promotes or inhibits drainage from the overburden. Visual inspection of outcrops and rock cores indicates that the upper one to two feet of the bedrock should have a permeability at least as great as and possibly greater than the overlying sand. Below the two-foot depth the bedrock is expected to have a permeability less than the overburden. Significant drainage of the overburden through bedrock exposed in an excavation is, therefore, expected to occur only to a depth of less than two feet below the top of bedrock. Any openings in exposed bedrock sufficient to cause piping of overburden must be treated.

GEOTECHNICAL DESIGN CONSIDERATIONS

20. MODIFICATIONS TO SILVER LAKE DAM

Geotechnical evaluations relative to Silver Lake Dam modifications were performed by A/E's under contract to the St. Paul District. Geotechnical design considerations relative to the proposed dam modifications were performed by Soil Exploration Co., Inc., (as a subcontract to Short-Elliott-Hendrickson, under contract to the St. Paul District), and are included in Addendum No. 1 to this appendix.

21. SILVER LAKE CHANNEL

A 175-foot wide trapezoidal channel, with 3H to 1V side slopes, is to be constructed through Silver Lake from Sta 127+00 to about 152+00. The depth of the channel varies from about two to four and one-half feet below its present elevation. It is anticipated that the very soft silt and silty clay soils will be removed by a barge mounted dredge prior to lowering the water level in the Lake for modifications to Silver Lake Dam.

22. ZUMBRO RIVER STA 152+00 TO 205+67

Upstream of about Sta 152+00 the existing channel will be widened and deepened with various channel bank protection measures employed

throughout the reach depending on real estate and structural considerations. Channel bank protection measures include:

a. 3H to 1V riprapped slopes,

b. 2 1/2H to 1V riprapped slopes, (limited use),

c. 2H to 1V rock fill slopes,

d. Gabion baskets located on slopes and channel bottom,

e. Concrete inverted T-walls,

f. Tied-back sheet pile walls, and

g. Bridge pier wing wall extensions.

The locations of each of the various bank protection measures are shown on plates 16 through 22 in the main report. Geotechnical design considerations for the various structures are presented subsequently.

23. BEAR CREEK STA 0+00 TO 6+50.

Within the limits of Reach 1B, Bear Creek will be deepened, widened, and partially relocated. The proposed modifications are shown on Plate 23 in the main report. The channel width will be increased to 80 feet. The channel depth will be increased by about four to five feet. Channel bank protection measures will consist of riprap placed on 3H to 1V side slopes, except adjacent to the 4th st. SE bridge where slope protection is planned to consist of gabion baskets. The gabions will also extend along the channel bottom in the area adjacent to the bridge.

SUBSURFACE EXPLORATION PROGRAM

24. INITIAL INVESTIGATION

The initial Reach 1B subsurface investigation, completed during the period April 1980 through March 1981, was performed as a part of the general investigation for the entire Rochester Flood Control Project. Eight machine borings were drilled within Reach 1B during that period by a Corps of Engineers drill crew. A listing of the eight borings is included in Table 1.

25. SUPPLEMENTAL INVESTIGATIONS

a. First Supplemental Investigation. Seven supplemental borings were completed in Reach 1B during February and March, 1983 in order to determine subsurface conditions adjacent to proposed sheetpile walls, and in areas requiring significant excavation. These borings are identified as the "First Supplemental Investigation" in Table 1. Upon completion of the First Supplemental Investigation it was noted that:

a. Significant qualities of rock could be encountered along the project alignment, and

b. Petrochemical based materials (pollutants), were encountered in boring 84-53M.

As a result of the findings of the first supplemental investigation, additional subsurface explorations were conducted. In addition to defining the location/characteristics of rock to be encountered and the extent of subsurface petrochemical substances, the additional explorations were also planned to:

1) Evaluate groundwater conditions at Silver Lake Dam,

2) Determine the characteristics of Silver Lake dredge spoils,

3) Define subsurface conditions adjacent to proposed wing walls and other structures, and

4) Determine the characteristics of materials to be excavated in areas of significant channel relocation.

b. Silver Lake Dam Investigation. Three borings and seven piezometer installations were completed in July, 1984 at the request of the A/E under contract to furnish Silver Lake Dam modification designs. The borings and piezometers were completed for the purpose of investigating groundwater conditions at Silver Lake Dam. The borings and piezometers are listed in Table 1 and noted "Silver Lake Dam".

c. Second Supplemental Investigation. Eighteen borings were completed to:

1) Define subsurface conditions adjacent to proposed and existing structures,
2) Confirm characteristics of Silver Lake Dam dredge spoils, and
3) Investigate additional areas of significant channel relocation.

The borings were completed during October, 1984 and are designated "Second Supplemental Investigation" in Table 1.

d. Bedrock Investigation. The final supplemental investigation was completed for the purpose of defining the quantity and characteristics of rock to be excavated within the channel and to determine the characteristics of rock on which various structures are to be founded. The investigation included 13 soil/rock borings and numerous rock probes. A list of the borings completed is included in Table 1 and noted "Rock Investigation". The numerous rock probes are not listed in Table 1, but are summarized on Plates B-1 through B-3.

e. Chronological Summary. A chronological summary of supplemental subsurface explorations is presented on Table 2.

26. BORING, PIEZOMETER AND ROCK PROBE LOCATIONS

Boring locations and staff logs are shown on Plates 16 through 23 in the main report. Detailed boring logs are presented on plates B-4 through B-10. Piezometer locations are shown on plate B-11. Sketches of piezometer installations are presented on plates B-12 and B-13. Rock probe locations are not plotted, but are summarized on Plates B-1 through B-3.

27. GENERAL SUBSURFACE STRATIGRAPHY

Subsurface conditions along the Reach 1B alignment, as interpreted from the results of the subsurface investigations, generally consist of alluvium overlying bedrock. At some locations man-made fills overly the alluvium . Within the Silver Lake Dam pool, very recent fine grained deposits overly the alluvium. The thickness of the alluvium varies from a few inches at bedrock outcroppings to 73 feet in the vicinity of Boring 80-13M. Within the predominantly granular alluvium, fine-grained clay and silt deposits were encountered. The deposits vary in consistency from soft to firm, are on the order of one to three feet thick, and appear to be discontinuous. Man-made fill thicknesses range from a few feet to about 20 feet adjacent to the west abutment of the Center Street bridge. Cross-sections illustrating subsurface conditions at various locations are illustrated on Plates B-14 and B-15. The locations of the sections are shown on Plate B-16.

LABORATORY TESTS

28. CLASSIFICATION TESTS

Geotechnical laboratory tests were performed to determine the physical properties and engineering characteristics of the various soils encountered within the project limits. Grain-size distribution determinations were completed to aid in the classification of granular materials. Atterburg limit and moisture content tests were performed on selected fine-grained materials. The results of the classification tests are presented on Plates B-17 through B-20. Plots of the grain-size analyses are given on Plates B-21 through B-35. A plasticity chart presenting the results of the Atterburg Limits tests is provided on Plate 36.

29. SHEAR STRENGTH TESTS

Eighteen direct shear tests were performed on materials from nine bag samples composed of composite materials obtained from five-inch diameter tube samples. Each bag was generally comprised of two three-foot long tube samples representing a six-foot long continuous column of soil. Classification tests were also performed on each bag sample, the results of which are presented on Plate B-37. The intent of the

direct shear tests was to test two groups of materials, SP's and SM's, representing clean alluvium and silty alluvium/man-made fills respectively, and to obtain shear strength parameters in "loose" and "dense" conditions for both groups in order to assess the range in shear strengths of both materials. For loose tests, materials were poured into the direct shear test mold with no attempt to densify the material. Dense tests were performed on materials that were placed into the direct shear test mold in layers with the mold being tapped with a hammer between layer placement in order to densify the material. The results of the individual direct shear tests are presented on Plates B-38 through B-46. Two consolidated-undrained triaxial compression, R-tests, were performed on materials from fine-grained layers encountered within the alluvium. A third sample planned for testing, (which crumbled during sample preparation), was classified a clayey sand and was not tested. Test results of the two triaxial compression tests are presented on Plates B-47 and B-48. Grain-size distribution curves and the results of Atterburg Limits tests for the two R-test samples are presented on Plate B-49.

30. SUMMARY OF TESTS PERFORMED

The number of tests performed on soils obtained within Reach 1B is as follows:

TEST	NUMBER
CLASSIFICATION TESTS	
Grain-Size Distribution	59
Atterberg Limits	13
Moisture Content	13
SHEAR STRENGTH TESTS	
"R" (Consolidated-undrained Triaxial Compression)	2
Direct Shear	18

In addition, grain-size distribution and moisture content tests were also completed on the two R-test samples and the nine direct shear tests samples. Atterberg limit determinations were also completed on the two R-test samples and four of the nine direct shear test samples. Specific gravity, (Gs), determinations were also completed for the two R-test samples.

31. DISCUSSION OF DIRECT SHEAR TEST RESULTS

a. Introduction. A plate summarizing the direct shear test results is presented on Plate B-50. Included on Plate B-51 is a plot of shear stress versus normal stress at failure, grain-size distribution curves of the nine samples, and a composite summary of the test results.

b. Soil Types. One of the primary purposes of the direct shear

tests was to test the two major types of soils encountered along the project alignment, poorly graded clean sands, (SP's), and silty or clayey sands, (SM's/SC's). As seen by the classifications on Plate B-37, the attempt to obtain an equal number of SP's and SM/SC's was not successful. Of the nine samples tested only one was classified a SP, (sacks 7 & 8 of Boring 84-78M, labeled sample No. 8 on Plate B-49). Of the eight SM/SC samples obtained, four were from fills and the other four were a composite of fill and Upper Alluvium.

c. Sample Relative Density. The second primary objective of the direct shear test program was to obtain the shear strength characteristics of samples in loose and dense conditions. The tabular summary of test results of Plate B-50 indicates that the samples were generally remolded into loose and dense conditions. For example, sample No. 1 was remolded to void ratios of 0.41 and 1.11 for dense and loose conditions respectively.

d. Shear Strength Characteristics. The plot of shear stress versus normal stress on Plate B-50 illustrates a high variability in shear stress, (obtained at a normal stress of 1500 pounds per square foot, psf), for the materials tested. Phi, Ø, angles developed from the test results, (assuming a cohesion intercept equal to zero), are likewise highly variable. Phi angles varied from 28 to 43 degrees for the loose samples and from 32 to 45 degrees for the dense samples. These ranges vary from that normally expected for silty sand. More typical Ø values for loose silty sand vary from 28 to 32 degrees and for dense silty sand range from 34 to 40 degrees. It can also be noted from the test results on Plate B-50 that for six of the nine samples the shear strength of the loose sample was greater than the strength of the dense sample. Various explanations for the unexpected shear strength test results can be put forward. One factor that may have contributed to the suspect results is the quantity and plasticity of the fines in the samples. That is, a zero cohesion intercept may not be appropriate for the soils in question. A second factor that may have contributed to the unexpected results is the potential for excess positive pore pressures to have existed in the dense samples due to tapping of the sample mold during sample preparation. Pore pressure dissipation may not have occurred prior to testing as anticipated, due to the quantity of fines in the samples, although sample No. 8 with vary few fines also exhibited a higher shear strength in a supposed "loose" condition.

e. Conclusions. The results of the direct shear tests are very suspect with regard to phi angle interpretation. The unit weights measured for the loose and dense samples appear to be reasonable, however. Recommendations regarding shear strength parameters presented in subsequent sections of this report will be based on Standard Penetration Resistance blow count correlations with angle of internal friction. Design unit weight values will be selected giving due consideration to the measurements obtained in the direct shear tests.

32. GENERAL

As previously described in paragraph 27, the generalized stratigraphy along the project alignment consists of alluvial and man-made fills overlying bedrock. Subsurface cross sections, presented on Plates B-14 and B-15, illustrate the existing stratigraphy. In addition to the existing materials, riprap, rockfill, and gabions will be used extensively within the project limits. The engineering properties of existing and imported materials are described below in paragraphs 33 through 41.

33. BEDROCK

The rock encountered in the project generally consists of dolomite and sandstone of the Shakopee Formation of the Prairie du Chien Group. Description of the rock types and a discussion of the engineering geology of the rock material are included in paragraphs 2 through 19 above. The principle concerns regarding the rock along the alignment are slope-forming characteristics and durability of exposed rock, and excavation characteristics. In accordance with recommendations contained in the GDM, additional borings were completed in order to better estimate the quantity of rock to be removed and to evaluate the rippability of the rock. Seventeen borings were completed in the channel in an effort to characterize the rock. Nine of the borings encountered rock at elevations which will require rock excavation. Core recovery varied from about 50 to 100 percent, RQD's (Rock Quality Determination) were completed for all rock cores, even where rock was encountered below the proposed channel excavation limits. RQD is defined as the total length of all unweathered pieces of core greater than or equal to four inches divided by the length of core run, expressed as a percent. RQD's were computed for runs: 1) above el. 696, (channel invert), 2) below channel invert and 3) total run length. RQD's above el. 696 varied from 16 percent to 52 percent. RQD's of the total core generally ranged from 25 percent to 56 percent. The core recoveries, RQD's, lithologic descriptions, and drilling characteristics were evaluated and an assessment of the rippability of the rock was made. The assessments of the thickness of rippable rock at various locations along with a summary of drilling information and RQD determinations are presented in Table 3. Table 3 indicates that the rippability of the rock varies from zero to seven feet below the top of rock, depending on location. Thus, while the majority of rock is anticipated to be rippable with a hydraulic (No. 9) ripper mounted on a D-9 dozer, some rock may require other methods of removal; methods previously described in paragraph 14 above.

34. The property of rock of concern for structures is the friction factor for sliding between concrete and bedrock. The friction factor assigned in the GDM, 0.839, is also recommended for use in final design. Where structures are founded on rock, the rock should be sound and durable. The ultimate bearing capacity of sound durable rock is

adequate for structures in Reach 1B founded on such rock. Where rock anchors are used to affix a structure to rock, the bonded length of the anchors should not include loose/jointed rock. Rock surfaces which are to form the base for structures should be inspected in the field to determine the acceptability of the rock for the intended purpose.

35. ALLUVIUM

a. Introduction. As mentioned in paragraph 27 above, the alluvium within the project limits generally consists of clean sands with occasional layers/lenses of fine-grained materials. As shown on Plates B-14 and B-15, the alluvium can be subdivided into two layers, designated "upper" and "lower" alluvium. The designations used here are not intended to link the materials geologically, but rather to describe materials with similar engineering characteristics.

b. Lower Alluvium. The lower alluvium is characterized by medium dense to very dense sand and gravel. Data from grain-size analyses completed on samples obtained from the lower alluvium are plotted on Plate B-51. The plot illustrates that the materials are relatively clean, with the majority of samples containing less than ten percent fines. A band width has been sketched on the plate to illustrate typical gradation curves for both the sand and gravel samples. The band widths show that the sands contain on the order of five to ten percent gravel, while the gravels typically contain 20 to 50 percent sand. Standard penetration test blow counts in the lower alluvium range form 12 to 100 blows per foot with a median of about 32 blows per foot. Using a correlation of Standard Penetration resistance to angle of internal friction, Ø, (as found in Figure b. of Plate B-51), an N value of 32 corresponds with a Ø of 36.5 degrees, say 36 degrees. Dry unit weights of the dense direct shear test samples of lower alluvium, (samples 6 and 8, Plate B-50), were converted to saturated weights of 133 and 135 pounds per cubic foot, pcf, respectively. Design unit weights selected were increased slightly to account for greater percentages of gravel encountered on the right bank where critical cross sections for stability are located. The unit weight values used in design are 135 and 138 pcf for moist and saturated conditions respectively.

c. Upper Alluvium. The upper alluvium is characterized by poorly graded very loose to medium dense sands. The sands encountered in the upper alluvium tend to be comprised of medium to fine-grained materials. Grain-size distribution test data of upper alluvium materials are plotted on Plate B-53. The plot illustrates the uniform gradation of the upper alluvium as indicated by the gradation band width presented on the plate. The plot also shows that the materials are relatively clean, with generally less than ten percent fines. Blow counts in the upper alluvium range from three to 12 blows per foot and average about seven blows per foot. Prior to correlating the penetration resistance, N, with Ø, a correction factor was applied to correct for overburden pressure, (Plate B-52, Figure a). For an effective vertical overburden pressure equal to 1000 psf, the

correction factor Cn is 1.2 and so the corrected N value is 8.4; say 9. An N of nine equates to a Ø of 30 degrees. Saturated unit weight values for very loose upper alluvium, (from the direct shear test samples), were computed to be about 108 pcf. Given that the very loose direct shear test samples represented conditions more loose than insitu field conditions, design unit weights were increased slightly to 115 and 120 pcf for moist and saturated conditions respectively.

36. EXISTING FILLS.

Fills within the project limits are highly variable. Some fills contain trash, while others are relatively clean. A plot of grain-size distribution test data from fill samples is given on Plate B-54. The plot shows that the fills generally consist of silty/clayey sand with the amount of gravel size particles varying from zero to about 20 percent, (although the gravel size particles may be trash). The grain-size distribution band width sketched on the plate illustrates the highly variable nature of the fills. Standard penetration blow counts in the fills range from two to 31 with a median of about 10, indicating that the fills vary in consistency from very loose to dense, but that the fills are generally loose. Design values for the existing fills were taken equal to those of the upper alluvium.

37. ROCK FILL

The rockfill will be quarried stone, angular to subangular in shape with reasonable control on gradation. For this reason a "conservative" angle of internal friction, of 38 degrees was selected for use in design. Rockfill design unit weight values were taken as 140 and 125 percent for saturated and non saturated conditions respectively.

38. LAKE BED DEPOSITS

Near surface soils in Silver Lake consist of very soft clayey silts and low plasticity clays deposited since construction of Silver Lake Dam. The materials contain occasional sand seams along with abundant wood particles, roots, and scattered gravel. No laboratory tests were completed on the Silver Lake bed deposits. However, the material is anticipated to have a buoyant unit weight of about 30 pcf. No shear strength values were assigned.

39. RIPRAP

Selection of riprap types was based on the hydraulic design requirements described in Appendix A. Riprap gradations and required minimum thicknesses were selected from ETL 1110-2-120, Enclosure 1, and ETL-1110-2-120, Enclosure 3. Riprap gradations are summarized in Table B-4.

40. BEDDING

Bedding gradations were designed in accordance with the criteria set

forth in EM 1110-2-1913, Appendix E. Selected gradations are presented on Table B-5. Plate B-55 illustrates the gradation difference between the upper and lower alluvium and shows that the upper alluvium is more fine-grained and uniform. Plate B-56 presents the riprap and bedding gradation curves along with the upper alluvium gradation band width. Shown on Plate B-57 is the gradation band of the bedding required for the upper alluvium based on the filter criteria of EM 1110-2-1913, Appendix E. Plate B-57 illustrates that bedding #1, the single layer bedding, is deficient with respect to acting as a filter for the upper alluvium. Plate B-57 also indicates that, with respect to Filter #1 and riprap type D, the piping criteria of EM 1110-2-1913, Appendix E is not met. Therefore, where a significant amount of upper alluvium is to be protected and/or where riprap type D is used, a double blanket (Filter #2 and Filter #3) is recommended. Riprap types B, C and E are similar to type D in that a double bedding layer should be used. Type 1 bedding can be used beneath riprap type A.

41. SUMMARY OF GEOTECHNICAL DESIGN PARAMETERS

A summary of geotechnical design parameters is presented on Table B-6.

DESIGN ANALYSIS

42. SEEPAGE AND UPLIFT PRESSURES

Seepage and uplift analyses, included in the GDM, were completed for levees along various portions of Bear and Cascade Creeks. Seepage and/or uplift are not of concern within Reach 1B.

43. SLOPE STABILITY

a. GENERAL. As discussed in paragraph 27 above, subsurface materials along the project alignment consist primarily of sand and gravel alluvium. The alluvial deposits, with three to ten percent fines are essentially free-draining, and short and long term strength parameters are considered to be equal. Fill materials encountered at the site have on the order of 20 percent fines and are generally well graded as illustrated on Plate B-54. The combination of the gradation and percentage of fines probably inhibits drainage to the extent that short and long term strength characteristics are not the same for the fill materials. However, critical sections for stability do not occur in areas with significant quantities of fill. The occasional pockets of firm to stiff fine-grained materials encountered along the alignment were not encountered in critical sections and are also not considered extensive enough to control stability in general.

b. 2 1/2H TO 1V RIPRAPPED SLOPES.

The majority of the riprapped channel slopes in Reach 1B are to be constructed with 3H to 1V side slopes. The exception occurs near station 180+00 on the right bank where the channel alignment has been rerouted around an existing building and a 2 1/2H to 1V slope is

planned. (The original plan included a tied-back sheet pile wall at station 180+00. The plan changed when rock was encountered near the proposed channel invert and it was considered that seating the sheetpile in the sloping uneven rock surface would be difficult). A 3H to 1V channel slope would have pushed the channel centerline to far to the left with regard to hydraulic and real estate considerations.

A cross-section through the 2 1/2H to 1V slope at station 180+10 is shown on plate B-58. The section shows the loose fill and upper alluvium, dense lower alluvium and bedrock typically encountered. Thicknesses of the various strata were interpreted from subsurface profiles C-C and D-D given on plate B-15.

The section was analyzed for end-of-construction, (E.O.C.), and partial pool, (P.P.), cases using the Corps of Engineers Computer Library Program I0013, "Slip Circle Slope Stability with Side Forces." Parameters used in the analyses are shown along with the results of the analyses on Plates B-59 through B-69. A summary of the results of the analyses is as follows:

CASE	(Factor of Safety) F.S
E.O.C.	1.54
P.P.	1.41

The infinite slope method, assuming no seepage, was also used to analyze slopes of 1V on 2 1/2H. For a uniform embankment of floodplain deposits with $\emptyset = 30$, the factor of safety is 1.44.

c. 2H ON 1V ROCKFILL SLOPES

2H on 1V rockfill slopes are planned in an area of restricted right-of-way from station 186+00 to 193+00 on the right bank. A cross-section through a critical section is shown on plate B-70. Very little subsurface information is available in the area to receive rockfill. The thicknesses of strata shown in the section were inferred from subsurface information available, (see plate B-15), just down stream of the section. The lack of more definitive subsurface information is due to the original plan, (GDM), having included 1V on 3H riprapped sideslopes, which were not considered to pose any stability problems. The cross-section, on Plate B-70 shows the proximity of bedrock to the slope surface and also shows bedrock daylighting within the limits of the channel to be excavated.

The section was analyzed for end-of-construction and partial pool cases using the Corps of Engineers Computer Library Program I0013, "Slip Circle Slope Stability with Side Forces." Parameters used in the analyses are shown, along with the results of the analyses, on Plates B-71 through B-78. A summary of the results of the analyses is as follows:

CASE	F.S.
E.O.C.	1.51
P.P.	1.40

If the infinite slope formula is used to evaluate the stability of a 1V on 2H slope, a failure plane located entirely in the loose fine sand, $\emptyset = 30$, would result in a factor of safety of 1.15. However, a significant portion of the failure plane must extend through the rock fill near the toe of the slope as illustrated on Plate B-78. Thus, the effect of the six-foot thick rockfill section is to act as a buttress, increasing the stability of the slope to acceptable levels.

STRUCTURES

44. The majority of the structures in Reach 1B, (in addition to Silver Lake Dam), consist of existing and proposed concrete or steel sheet pile retaining walls, bike path underpass structures, and bridge pier and wing wall extensions. Geotechnical considerations for Silver Lake Dam are discussed in Addendum No. 1 to this appendix. Structural designs for the various structures are included in Appendix C. Geotechnical parameters for use in structural design are presented in Table B-6. New structures should generally be founded on competent and durable bedrock, the dense lower alluvium, or be supported on piles.

CONSTRUCTION CONSIDERATIONS

45. DEWATERING.

Dewatering will be required for much of the structural work and rock excavation to be performed within Reach 1B. Dewatering is also contemplated for channel excavation above station 152+00 so that slope protection can be placed in the dry. Dewatering will likely consist of earthen cofferdams augmented with french drains and sump pumps and/or well points as required. The outboard slopes of cofferdams may require temporary erosion/scour protection.

46. EXISTING STRUCTURES.

Existing retaining walls, wing walls, bridge piers and abutments are planned to be modified. Modifications are to include scour protection and/or structural foundation modifications. The modifications should be completed prior to temporary channelization of water past these structures in a deepened channel. Failure to do so may result in erosion/scour of foundation materials and subsequent foundation failure.

47. TEMPORARY EXCAVATION SLOPES.

Slopes as steep as 1 1/2H to 1V are expected to remain stable for temporary construction excavations. The use of sheetpile or other

cantilevered shoring systems may be limited to areas where bedrock is deep enough to permit their use. Special sumps and/or well points may be required in sheeted excavations to prevent foundation heave and/or boiling depending on the differential heads experienced.

48. EXCAVATIONS ADJACENT TO BUILDINGS.

Several construction excavations will be required immediately adjacent to existing buildings. Temporary sheeting and/or foundation support will be required at those locations depending on the type and configuration of the foundation at each location. The locations at which temporary shoring and/or foundation treatment will be required include:

LOCATION (STATION)	BUILDING	CONSTRUCTION FEATURE
181+00 left bank	-	Sheetpile wall deadman
182+00 left bank	-	Sheetpile wall deadman
185+00 left bank	City Art Center	Sheetpile wall deadman

49. ROCK EXCAVATION

a. CHANNEL. Deepening of the channel bed below its present elevation will require excavation of bedrock. Studies and subsurface investigations indicate that bedrock will be encountered between the Rochester Power Plant and Mayo Park near the Center Street bridge. The bedrock is estimated to be rippable to depths varying from zero to seven feet. Removal of some rock by means other than ripping will probably be required.

b. RETAINING WALLS AND SCOUR PROTECTION. Walls situated along the left bank are outside the limits of the shallow bedrock and construction thereof will generally not require rock removal (except adjacent to the power plant). The concrete retaining walls along the right bank will require rock removal. The majority of the removal is anticipated to be within rippable depth. However, removal by jackhammer or other means will likely be required in isolated areas such as adjacent to existing structures and for removal of fractured rock for wall foundations.

50. GROUND WATER

The water table along the narrow project corridor is the same as the water levels of the streams. Therefore, as the channels are deepened, drainage of the surrounding ground water must be sufficiently slow that piping or sloughing of sand does not occur. Normally, drainage will occur naturally as excavation progresses and no problems are anticipated. In some areas where excavation exceeds channel depth, temporary dewatering with shallow wells may be required. For the most

part, however, all that will be required is an awareness of the potential for piping or sloughing of soil banks so that excavation rates can be slowed if problems appear imminent.

51. CONSTRUCTION MATERIALS

Construction materials required for the project consist of riprap, bedding, rockfill for gabion baskets, rock fill and concrete aggregate. The availability of adequate resources has been verified, and materials from most sources have been used recently and exhibited suitable performance.

52. CONCRETE AGGREGATE

Fine aggregate for concrete is available from producing pits in the valleys of the South Fork Zumbro River and Cascade Creek. Aggregate from these pits is natural sand and has been used extensively and successfully for may years in the Rochester area. Producing pits are located less than two miles from the city. Natural course aggregate does not exist in the area; therefore, coarse material must be manufactured from quarries in the Shakopee and Oneota Formations. The closest operating quarries are located six to 16 miles north of the city and have been used extensively by the Minnesota Department of Transportation. Recent test data obtained from that agency and the producer indicate no problem will be encountered in establishing approval of a source.

53. RIPRAP, BEDDING AND FILL FOR GABION BASKETS

Acceptable riprap, bedding and fill for gabion baskets can be produced from the same sources that produce coarse concrete aggregate. Two rock quarries, 63 West Quarry and Goldberg Quarry are within 4.5 and 6.0 miles respectively of the project site. In addition, rock from the Galena Formation which is quarried within ten miles south of the city has been used extensively for riprap by state and local agencies. Inspection of quarries and in-place riprap indicates that riprap from this formation can be expected to show three to seven percent breakage within three years after placement. Additional evaluation will, therefore, be necessary to approve quarries producing from the Galena Formation.

54. ROCK FILL

Acceptable material for rock fill can be produced from quarries in the Shakopee and Oneota Formations. The quarries in the Galena Formation can produce material for rock fill if gradation requirements are sufficiently broad to accommodate an anticipated breakage of three to seven percent of the material at the surface. In any case, adequate material is available within six to 16 miles of any part of the project.

REACH 1B SUBSURFACE EXPLORATION SUMMARY

BORING	STATION ~ (APPROXIMATE LOCATION)	DATE COMPLETED	AGENCY	NOTES
80-13M	127+00	4-28-80	USCEC	
80-14M	126+00	4-30-80	USCEC	
80-20M	160+00	5-8-80	USCEC	INITIAL
80-21M	187+00	5-12-80	USCEC	INVESTIGATION
80-22M	200+00	5-12-80	USCEC	
80-23M	176+00	5-13-80	USCEC	
81-37M	3+00 B.C.	1-15-81	USCEC	
81-44M	126+75	2-3-81	USCEC	
83-52M	173+00	3-1-83	USCEC	
83-53M	175+00	3-2-83	USCEC	
83-54M	130+00	3-3-83	USCEC	FIRST
83-55M	136+00	3-3-83	USCEC	SUPPLEMENTAL
83-56M	191+00	3-3-83	USCEC	INVESTIGATION
83-57M	132+00	3-5-83	USCEC	
83-61M	185+00	3-8-83	USCEC	
84-62M	126+75	7-10-84	SEC (1)	
84-63M	126+75	7-11-84	SEC	SILVER LK DM
84-64M	126+75	7-11-84	SEC	
84-65M	156+00	10-16-84	USCEC	
84-66M	173+00	10-17-84	USCEC	
84-67M	186+00	10-18-84	USCEC	
84-68M	183+00	10-18-84	USCEC	
84-73M	187+00	10-22-84	USCEC	
84-74M	197+00	10-22-84	USCEC	
84-75M	203+00	10-22-84	USCEC	SECOND
84-76M	175+00	10-24-84	USCEC	SUPPLEMENTAL
84-77M	176+00	10-24-84	USCEC	INVESTIGATION
84-78M	177+00	10-24-84	USCEC	
84-79M	180+00	10-25-84	USCEC	
84-80M	182+00	10-25-84	USCEC	
84-82M	169+00	10-27-84	USCEC	
84-86M	178+00	10-31-84	USCEC	
84-87M	184+00	12-1-84	USCEC	
84-88M	148+00	10-12-84	USCEC	
84-89M	139+00	10-12-84	USCEC	
84-90M	131+00	10-13-84	USCEC	

ROCHESTER FLOOD CONTROL
DM No. 2 REACH 1B
TABLE 1

REACH 1B SUBSURFACE EXPLORATION SUMMARY

BORING	STATION (APPROXIMATE LOCATION)	DATE COMPLETED	AGENCY	NOTES
85-91M	180+50	11-21-85	TCT-R(2)	ROCK INVESTIGATION
85-92M	175+50	11-22-85	TCT-R	
86-93M	182+50	4-5-86	USCEC	
86-94M	179+00	4-7-86	USCEC	
86-95M	177+50	4-8-86	USCEC	
86-96M	186+00	4-9-86	USCEC	
86-97M	188+00	4-10-86	USCEC	
86-98M	174+00	4-11-86	USCEC	
86-99M	173+00	4-11-86	USCEC	
86-100M	171+00	4-12-86	USCEC	
86-101M	170+09	4-17-86	USCEC	
86-102M	168+00	5-9-86	USCEC	
86-103M	169+50	5-10-86	USCEC	
PIEZOMETER				
P-1	126+75	7-10-84	SEC	SILVER LK. DAM.
P-2	126+75	7-11-84	SEC	
P-3	126+75	7-12-84	SEC	
P-4	126+75	7-12-84	SEC	
P-5	126+75	7-12-84	USCEC	
P-6	126+75	7-13-84	USCEC	
P-7	126+75	7-13-84	USCEC	

Notes:
1. Soil Exploration Company, Inc.
2. Twin Cities Testing, Inc. (Rochester office)

TABLE 2

CRONOLOGICAL SUMMARY OF SUBSURFACE EXPLORATION
ROCHESTER FLOOD CONTROL - REACH 1B

Approximate Dates	Item	Purpose(s)
APR & MAY 1980 JAN & FEB 1981	Borings 13, 14, 21, 22, 23, 32, & 44	Initial investigation
MAR 1983	Borings 52 - 57 & 61	Obtain subsurface information for sheetpile walls and excavations
JUL 1984	Borings 62 - 64 & Piezometers 1 - 7	Evaluate groundwater conditions at Silver Lake Dam
OCT 1984	Borings 65 - 68, 73 - 80, & 86 - 90	Evaluate Silver Lake dredge spoils, Obtain info for structures, & Obtain info for channel relocations
NOV 1985 & APR & MAY 1986	Borings 91 - 103 & Rock Probes 1 - 316	Determine extent and characteristics of bedrock

DESIGN MEMORANDUM NO. 2 PHASE 1B, - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

TABLE 2
CRONOLOGICAL SUMMARY OF
SUBSURFACE EXPLORATION

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987

TABLE 3

ROCK PROPERTY SUMM

BORING No.	APPROX. LOCATION (STA.)	TOP OF ROCK (ELEV. FT. M.S.L.)	ROCK TYPE CHANGES (ELEV)	BOTTOM OF BORING (FT. M.S.L.)	PERCENT RECOVERY
84-86M	178+00	980.8 Dol.	976.1 S.St. 973.0	Dol. 971.9	80
84-87M	184+00	972.7 Dol.	969.7 S.St. 967.4	Dol. 965.5	Roller Bit
85-91M	180+50	962.7 Dol.	959.3	S.St. 957.2	54
85-92M	175+50	961.1 Dol.	959.4	S.St. 956.8	26
86-93M	182+50	972.8 Dol.	971.4 - S.St. 966.6 - Dol. 965.1	963.7	95
86-94M	179+00	960.8 S.St.	958.9 Dol	957.2	92
86-95M	177+50	957.7 S.St.	955.6 Dol.	953.2	73
86-96M	186+00	971.6 Dol.	970.0 - S.St. 968.3 - Dol. 965.9	S.St. 961.4	100
86-97M	188+00	973.6 Dol.	971.8 - S.St. 970.6 - Dol. 968.5	S.St. 967.8	93
86-98M	174+00	961.2 Dol.	960.0 S.St. 956.6	Dol. 956.1	56
86-99M	173+00	974.1 Dol	ALT. 1 to 2 Ft Layers S.St & Dol	Dol. 963.6	93
86-100M	171+00	975.3 Dol	Alt. 1 to 2-FT Layers S.St & Dol.	L.St. 963.3	91
86-101M	170+00	971.9 Dol.	970.4 S.St. 968.9	S.St. 966.9	82
86-102M	168+00	972.6 Dol	ALT 1 to 2-FT LAYERS S.ST & Dol	Dol. 965.6	73
86-103M	169+50	971.8 S.St.	Alt. 1 to 2-FT Layers S.St & Dol.	Dol. 965.5	84

NO. 4770. DATA SHEET. ONE YEAR OR ONE MONTH BY DATE.

TABLE 3

ROCK PROPERTY SUMMARY

TYPE IGES)	BOTTOM OF BORING (FT. M.S.L.)	PERCENT RECOVERY	RQD BELOW EL. 969	RQD ABOVE EL. 969	RQD (TOTAL)	ESTIMATED THICKNESS OF RIPABLE ROCK	(
St. 973.0	Dol. 971.9	80	-	-	21	-	Not ıı
St. 967.4	Dol. 965.5	Roller Bit	-	-	-	-	Lost al
.3	S.St. 957.2	54	10	N.A.	10	N.A.	Abundar
.4	S.St. 956.8	26	-	-	-	-	used Bx
Dol. 6.6-965.1	963.7	95	49	23	39	4.4 FT	Bedding , breaks ap,
Dol 8.9	957.2	92	39	0	39	2.9 FT	(See
Dol. 5.6	953.2	73	55	0	55	2.1 FT	Vuggy, p
Dol. 8.3-965.9	S.St. 961.4	100	36	52	40	0	
Dol. 0.6-968.5	S.St. 967.8	93	100	39	56	2.8 FT	
St. 956.6	Dol. 956.1	56	-	-	0	5.0 FT	Poor re sandsto
62 FT S.St & Dol	Dol. 963.6	93	30	44	37	4.0 FT	
2-FT S.ST & Dol.	L.St. 963.3	91	46	45	44	3.1 FT	Abundant
S.ST. 968.9	S.St. 966.9	82	0	21	16	5.0 FT	
2-FT S.ST & Dol	Dol. 965.6	73	33	17	25	7.0 FT	
2-FT S.ST & Dol.	Dol. 965.5	84	48	16	32	4.2	

DESIGN MEMORA

St. Paul Dist

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RQD (TOTAL)	ESTIMATED THICKNESS OF RIPABLE ROCK	COMMENTS	
21	-	Not in channel	
-	-	Lost all drilling water, 972	
10	N.A.	Abundant mechanical breaks	
-	-	used BX barrel, poor rec.	
39	4.4 FT	Bedding planes/mechanical breaks appear similar in S.ST.	
39	2.9 FT	(see 86-93M)	
55	2.1 FT	Vuggy, pitted & Abund. Mech. Bks	
40	0		
56	2.8 FT		
0	5.0 FT	Poor recovery in non-cemented sandstone.	
37	4.2 FT		
44	3.1 FT	Abundant small vuggs	
16	5.2 FT		
25	7.[illegible] FT		
32	4.2		

DESIGN MEMORANDUM NO. 2 PHASE 1B, - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

TABLE 3
ROCK PROPERTY SUMMARY

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987

TABLE B-4

RIPRAP GRADATIONS
FOR ROCHESTER FLOOD CONTROL PROJECT

Type	Required Minimum Thickness (in)	% Lighter by Weight	Limits of Stone Weight (lb)
A	12	100	35-86
		50	17-26
		15	5-13
B	18	100	117-292
		50	58-86
		15	18-43
C	24	100	82-205
		50	41-86
		15	13-43
D	27	100	117-292
		50	58-123
		15	18-62
E	30	100	160-400
		50	80-169
		15	25-84

TABLE B-5

FILTER AND BEDDING GRADATIONS
FOR ROCHESTER FLOOD CONTROL PROJECT

Filter and Bedding Types: Sieve Size	1	2	3
	(Total % Percent Passing)		
6"	100	100	-
3"	87-100	60-100	-
1-1/2"	69-100	20-60	-
1"	-	0-45	100
3/4"	45-68	-	-
1/2"	-	0-15	82-100
3/8"	24-47	0-5	-
No. 4	10-33	-	48-74
No. 10	0-19	-	14-37
No. 20	0-10	-	0-15
No. 40	0-5	-	0-5

* Refer to Plate B-3 for notes on stationing.

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Refusal Elevation	Probe Elevation not to Refusal
1	162+35		140		965.8
2	162+57	97			965.8
3	162+69		7		965.8
4	163+52		140		965.8
5	163+72	83			965.8
6	163+96	0	0		965.8
7	164+80		132		965.8
8	164+86	83			965.8
9	165+08	3			965.8
10	165+77		37		965.8
11	165+81		66		965.8
12	165+83		7		965.8
13	165+84		95		965.8
14	165+87	74			965.8
15	165+93	56			965.8
16	165+94	25			965.8
17	166+03		125		965.8
18	166+33	63			965.8
19	166+43	33			965.8
20	166+45	75			965.8
21	166+51		3		965.8
22	166+55		41		965.8
23	166+55		74		965.8
24	166+59		115		965.8
25	166+67		88		965.9
26	166+68		53	966.0	
27	166+68		71	966.4	
28	166+74		44		965.8
29	166+85		50	971.6	
30	166+87		47	971.5	
31	166+97		68	968.6	
32	167+01		124	966.8	
33	167+03		19		965.8
34	167+03	91			965.8
35	167+07	43			965.8
36	167+08		34	967.3	
37	167+10		107	969.4	
38	167+12	15			965.8
39	167+13		10	966.4	
40	167+15		110	969.9	
41	167+18		46	971.7	
42	167+19		92	971.5	

Probe Number	Station	Dis Lef Cen Lin
43	167+24	
44	167+25	
45	167+27	
46	167+27	
47	167+44	
48	167+46	
49	167+47	
50	167+51	
51	167+54	
52	167+55	
53	167+60	
54	167+60	
55	167+62	
56	167+64	
57	167+73	
58	167+84	
59	167+91	
60	167+93	
61	167+97	
62	168+02	
63	168+07	
64	168+07	
65	168+08	
66	168+09	
67	168+10	
68	168+10	
69	168+12	
70	168+18	
71	168+20	
72	168+21	
73	168+27	
74	168+30	
75	168+38	
76	168+41	
77	168+46	
78	168+46	
79	168+47	
80	168+47	
81	168+53	
82	168+53	
83	168+54	
84	168+55	

ing.

...usal ...ation	Probe Elevation not to Refusal
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.8
	965.9
966.0	
966.4	
	965.8
971.6	
971.5	
968.6	
966.8	
	965.8
	965.8
	965.8
967.3	
969.4	
	965.8
966.4	
969.9	
971.7	
971.5	

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Refusal Elevation	Probe Elevation not to Refusal
43	167+24		86	970.3	
44	167+25		75	970.5	
45	167+27		36	971.6	
46	167+27		57	970.9	
47	167+44	3		967.3	
48	167+46		75	970.6	
49	167+47	50			965.5
50	167+51	1		967.3	
51	167+54		91	971.8	
52	167+55	87			965.5
53	167+60	38			965.8
54	167+60		113	971.6	
55	167+62		103	970.4	
56	167+64		88	971.7	
57	167+73	23		966.7	
58	167+84	1		970.1	
59	167+91	41		966.4	
60	167+93		112	974.3	
61	167+97	62			965.8
62	168+02	36		967.6	
63	168+07		43	971.8	
64	168+07		72	973.1	
65	168+08		82	973.5	
66	168+09		112	974.3	
67	168+10	3		968.3	
68	168+10	45		968.9	
69	168+12	73			965.8
70	168+18	65		965.3	
71	168+20	80		965.1	
72	168+21	7		968.4	
73	168+27	9		970.8	
74	168+30		1	972.6	
75	168+38	24		969.8	
76	168+41	5		969.8	
77	168+46	46		967.8	
78	168+46		36	971.7	
79	168+47		58	972.3	
80	168+47		65	972.3	
81	168+53	53		972.3	
82	168+53	71		967.8	
83	168+54		98	973.0	
84	168+55		71	970.8	

Probe Number	Station	Distan... Left of Center Line
85	168+59	
86	168+59	
87	168+60	
88	168+63	13
89	168+67	
90	168+67	
91	168+67	
92	168+67	41
93	168+69	
94	168+74	
95	168+76	12
96	168+88	97
97	168+99	29
98	169+00	
99	169+00	
100	169+03	
101	169+15	45
102	169+17	65
103	169+20	
104	169+35	
105	169+49	
106	169+54	18
107	169+54	
108	169+59	
109	169+60	
110	169+69	
111	169+76	38
112	169+76	
113	169+81	
114	169+82	
115	169+92	
116	169+92	

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Refusal Elevation	Probe Elevation not to Refusal
85	168+59		57	971.8	
86	168+59		85	972.9	
87	168+60		37	972.1	
88	168+63	13		972.3	
89	168+67		64	970.7	
90	168+67		27	972.3	
91	168+67		81	971.6	
92	168+67	41		972.3	
93	168+69		78	970.6	
94	168+74		15	972.3	
95	168+76	12		972.4	
96	168+88	97		971.8	
97	168+99	29		970.6	
98	169+00		88	970.5	
99	169+00		100	967.3	
100	169+03		79	971.8	
101	169+15	45		971.0	
102	169+17	65		971.8	
103	169+20		43	971.1	
104	169+35		19	971.8	
105	169+49		93	974.0	
106	169+54	18		971.9	
107	169+54		84	973.8	
108	169+59		91	973.6	
109	169+60		65	974.4	
110	169+69		44	973.9	
111	169+76	38		970.8	
112	169+76		71	973.6	
113	169+81		82	973.4	
114	169+82		6	971.7	
115	169+92		36	974.0	
116	169+92		81	973.2	

DESIGN MEMORANDUM NO. 2

PHASE 1B - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

ROCK PROBE SUMMARY
SHEET 1 OF 3

St. Paul District, U.S. Army Corps of Engineers
File No.
January 1987
PLATE B-1

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Refusal Elevation	Probe Elevation not to Refusal
117	169+95		90	972.4	
118	169+98	78		971.9	
119	169+98	88		972.3	
120	170+01		78	971.8	
121	170+05		105	970.5	
122	170+06	22		971.3	
123	170+16		62	971.3	
124	170+19		88	967.5	
125	170+20		65	970.4	
126	170+30		93	968.8	
127	170+31		61	971.2	
128	170+31		100		966.8
129	170+43	74		975.1	
130	170+43		24	971.4	
131	170+45		96	971.2	
132	170+50	14		973.4	
133	170+50	25		973.5	
134	170+50		80		966.8
135	170+56	37		973.8	
136	170+62	80		975.6	
137	170+74		56		966.8
138	170+82			970.8	
139	170+85		80		966.8
140	170+86		56		966.8
141	170+92	57		974.0	
142	171+04		15	969.7	
143	171+04		58		966.8
144	171+07	86		976.4	
145	171+08		46		966.8
146	171+12	65		975.4	
147	171+12	74		975.3	
148	171+22		11	970.0	
149	171+22	27		974.3	
150	171+24	36		974.6	
151	171+25	12		969.5	
152	171+33	78		975.7	
153	171+35	35		975.1	
154	171+43		42		966.8
155	171+45		46		966.8
156	171+50	75		975.4	
157	171+54	63		974.6	
158	171+54	85		975.7	

Probe Number	Station	Dista[nce] Left o[f] Cente[r] Line
159	171+75	11
160	171+78	22
161	171+83	30
162	171+88	33
163	171+90	38
164	171+94	46
165	171+96	56
166	172+00	64
167	172+00	71
168	172+00	87
169	172+03	75
170	172+21	
171	172+23	70
172	172+29	
173	172+30	83
174	172+54	0
175	172+62	23
176	172+62	83
177	172+62	
178	172+67	62
179	172+69	51
180	172+69	57
181	172+72	74
182	172+80	59
183	172+84	45
184	172+92	1[illegible]
185	172+92	7[illegible]
186	173+09	7[illegible]
187	173+13	4[illegible]
188	173+20	
189	173+46	7[illegible]
190	173+69	2[illegible]
191	173+88	3[illegible]
192	174+06	5[illegible]
193	174+61	8[illegible]
194	174+75	
195	174+75	
196	175+00	
197	175+13	7[illegible]
198	175+17	3[illegible]
199	175+35	6[illegible]
200	175+56	7[illegible]

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Refusal Elevation	Probe Elevation not to Refusal
159	171+75	11			966.8
160	171+78	22		969.4	
161	171+83	30		969.9	
162	171+88	[illegible]		973.2	
163	171+90	[illegible]		973.2	
164	171+94	46		972.8	
165	171+96	56		973.2	
166	172+00	64		973.6	
167	172+00	41		974.1	
168	172+00	87		975.8	
169	172+03	75		975.1	
170	172+21		53		966.8
171	172+23	70		973.8	
172	172+29		36		966.0
173	172+30	83		975.2	
174	172+54	[illegible]	0		966.8
175	172+62	23			966.8
176	172+62	83		975.7	
177	172+62		52		966.8
178	172+67	62		972.5	
179	172+69	51		968.0	
180	172+69	57		970.8	
181	172+72	74		974.5	
182	172+80	59		969.5	
183	172+84	45		966.8	
184	172+92	12		966.8	
185	172+92	77		974.1	
186	173+09	72		970.5	
187	173+13	42			966.8
188	173+20		12		966.8
189	173+46	73		968.0	
190	173+69	25			966.8
191	173+88	38			966.8
192	174+06	53			966.8
193	174+61	88			966.8
194	174+75		31		966.6
195	174+75		54		966.6
196	175+00		4		966.8
197	175+13	73		962.2	
198	175+17	30			966.6
199	175+35	60			966.6
200	175+56	76			966.6

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Re El
201	176+18	78		
202	176+23	78		
203	176+62	84		
204	176+68		55	
205	176+90		23	
206	176+97	90		
207	177+22		4	
208	177+27	42		
209	177+43	79		
210	177+44	76		
211	178+34	101		
212	178+55	107		
213	178+81	16		
214	178+83		31	
215	178+92	50		
216	178+97	82		
217	179+18	109		
218	179+95	107		
219	180+53		21	
220	180+55		50	
221	180+69	40		
222	180+69	93		
223	180+74	55		
224	180+74	81		
225	181+10	84		
226	181+37		20	
227	181+44	71		
228	181+50	10		
229	181+62		62	
230	181+65		28	
231	181+65	44		
232	181+68	70		

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St. Paul Distri
File No.

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Refusal Elevation	Probe Elevation not to Refusal
201	176+18	78		965.7	
202	176+23	78		965.7	
203	176+62	84		961.2	
204	176+68		55		966.6
205	176+90		23		966.6
206	176+97	90		958.5	
207	177+22		4		966.6
208	177+27	42			966.6
209	177+43	79		967.4	
210	177+44	76			966.6
211	178+34	101		958.7	
212	178+55	107		960.0	
213	178+81	16			966.6
214	178+83		31		966.6
215	178+92	50			966.6
216	178+97	82			966.6
217	179+18	109			966.6
218	179+95	107		962.1	
219	180+53		21		966.6
220	180+55		50		966.6
221	180+69	40			966.6
222	180+69	93			966.6
223	180+74	55			966.6
224	180+74	81			966.6
225	181+10	84		964.9	
226	181+37		20		966.6
227	181+44	71			966.6
228	181+50	10			966.6
229	181+62		62		966.6
230	181+65		28		966.6
231	181+65	44			966.6
232	181+68	70			966.6

DESIGN MEMORANDUM NO. 2

PHASE 1B - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

ROCK PROBE SUMMARY
SHEET 2 OF 3

St. Paul District, U.S. Army Corps of Engineers
File No.

January 1987
PLATE B-2

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Refusal Elevation	Probe Elevation not to Refusal
233	181+68	74		969.7	
234	181+83	57			966.6
235	181+84	19			966.6
236	181+87	67		967.3	
237	181+87	72		967.6	
238	182+10	49			966.6
239	182+20	52		966.6	
240	182+20	56		970.0	
241	182+23	47		966.6	
242	182+24	60		971.0	
243	182+25	62		971.5	
244	182+25	66		972.4	
245	182+80		72		966.5
246	183+04	42			966.5
247	183+04	44		–	966.5
248	183+07		38		966.5
249	183+08	55		970.1	
250	183+13	63		969.1	
251	183+13	68		971.3	
252	183+36	10			966.5
253	183+50	30			966.5
254	183+62	45		966.5	
255	183+62	57		970.8	
256	183+63	47	—	967.5	
257	183+63	54		966.5	
258	183+65	63		974.4	
259	183+67	60		970.4	
260	184+11		54		966.5
261	184+28		28		966.5
262	184+34	50			966.5
263	184+34	55			966.5
264	184+41	60		970.4	
265	184+47	6			966.5
266	184+47	72		971.0	
267	184+53	19			966.5
268	184+63	53			966.5
269	184+71	63			966.5
270	184+73	58			966.5
271	184+76	68		972.1	
272	184+76	80		972.9	
273	184+80	76		970.1	
274	185+42	0	0		966.5

Probe Number	Station	Dista[illegible] Left [illegible] Cente[illegible] Line
275	185+47	
276	185+55	30
277	185+59	41
278	185+69	72
279	185+69	77
280	185+70	63
281	186+80	56
282	186+88	54
283	186+88	60
284	186+88	86
285	186+89	6[illegible]
286	186+89	8[illegible]
287	187+03	
288	187+18	5[illegible]
289	187+22	6[illegible]
290	187+26	6[illegible]
291	187+26	8[illegible]
292	187+26	
293	187+30	7[illegible]
294	187+46	1[illegible]
295	187+56	2[illegible]
296	187+62	4[illegible]
297	187+70	5[illegible]
298	187+70	5[illegible]
299	187+70	6[illegible]
300	187+72	7[illegible]
301	187+75	5[illegible]
302	188+54	4[illegible]
303	188+55	3[illegible]
304	188+55	5[illegible]
305	188+60	6[illegible]
306	188+60	7[illegible]
307	188+60	8[illegible]
308	188+87	5[illegible]
309	188+91	4[illegible]
310	188+96	[illegible]
311	188+98	[illegible]
312	190+88	[illegible]
313	190+90	[illegible]
314	190+93	[illegible]
315	190+97	[illegible]
316	191+00	[illegible]

Probe Number	Station	Distance Left of Center Line	Distance Right of Center Line	Refusal Elevation	Probe Elevation not to Refusal
275	185+47		55		966.5
276	185+55	30			966.5
277	185+59	41			966.5
278	185+69	72		972.0	
279	185+69	77		973.7	
280	185+70	63		969.4	
281	186+80	56			966.5
282	186+88	54			966.5
283	186+88	60		969.4	
284	186+88	86		970.7	
285	186+89	67		968.7	
286	186+89	81		970.9	
287	187+03		77		966.5
288	187+18	53			966.5
289	187+22	60			966.5
290	187+26	65		970.9 Boulder	
291	187+26	83		967.5	
292	187+26		45		966.5
293	187+30	74		967.4	
294	187+46	11			966.5
295	187+56	26			966.5
296	187+62	43			966.5
297	187+70	54			966.3
298	187+70	57		968.3	
299	187+70	67		968.1	
300	187+72	74		971.4	
301	187+75	58			966.5
302	188+54	44		970.8	
303	188+55	37			966.6
304	188+55	55		971.3	
305	188+60	66		971.8	
306	188+60	74		972.3	
307	188+60	81		972.8	
308	188+87	57		971.8	
309	188+91	47		971.7	
310	188+96	37		971.8	
311	188+98	22			966.6
312	190+88	43			966.6
313	190+90	52		967.7	
314	190+93	62		968.6	
315	190+97	72		968.6	
316	191+00	84		969.1	

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Probe Notes

1. Probes are numbered from down upstream and are referenced l of the channel center line as increases.

2. The probes were taken from a a portable drill rig. The pr 1½" steel rod advanced with a hammer.

3. The probes were located using and stadia rod.

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St. Paul Distric
File No.

Probe Notes

1. Probes are numbered from downstream to upstream and are referenced left or right of the channel center line as the stationing increases.

2. The probes were taken from a pontoon with a portable drill rig. The probe was a solid 1½" steel rod advanced with a 140-pound hammer.

3. The probes were located using a transit and stadia rod.

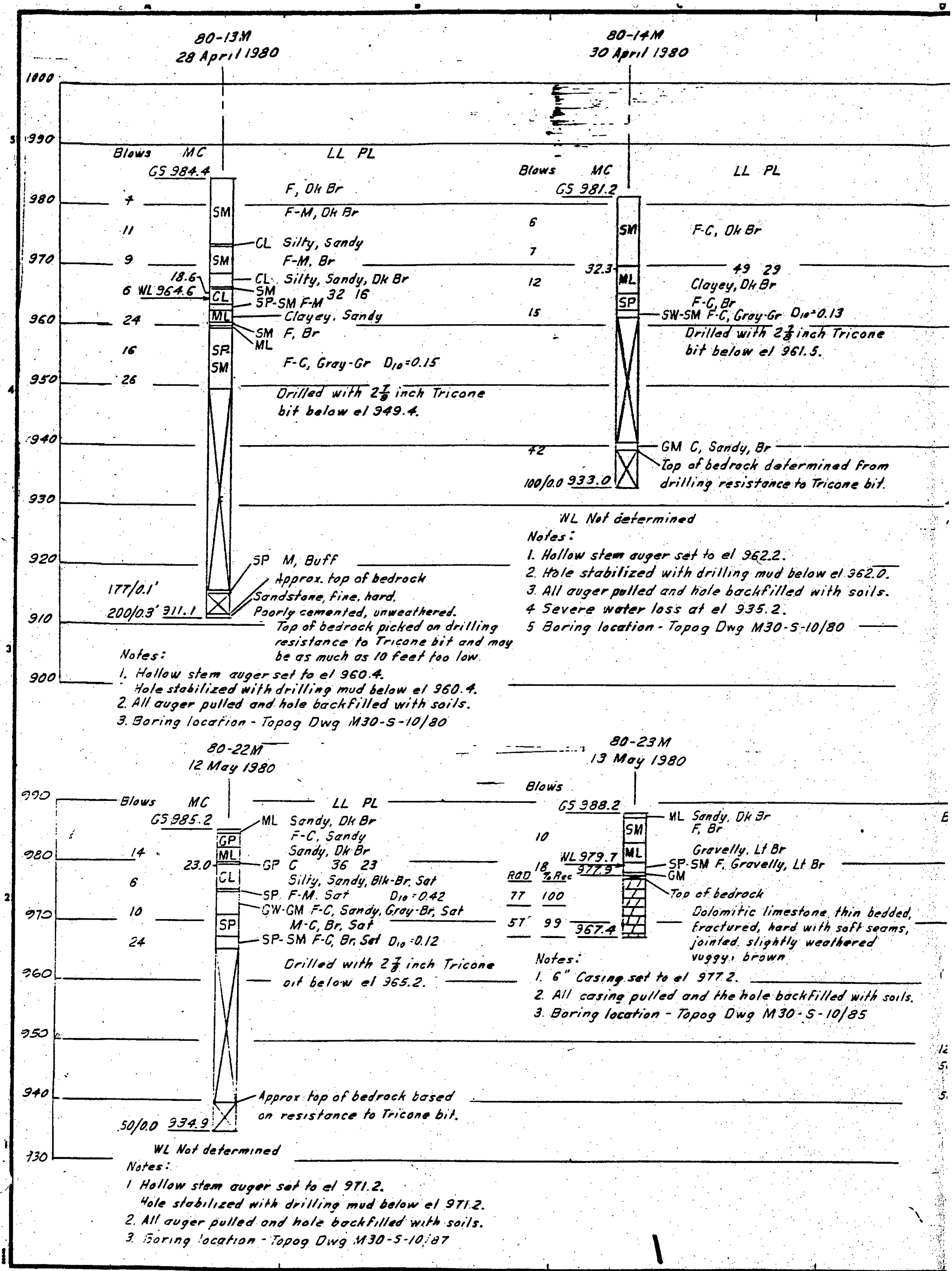
DESIGN MEMORANDUM NO. 2 PHASE 1B - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

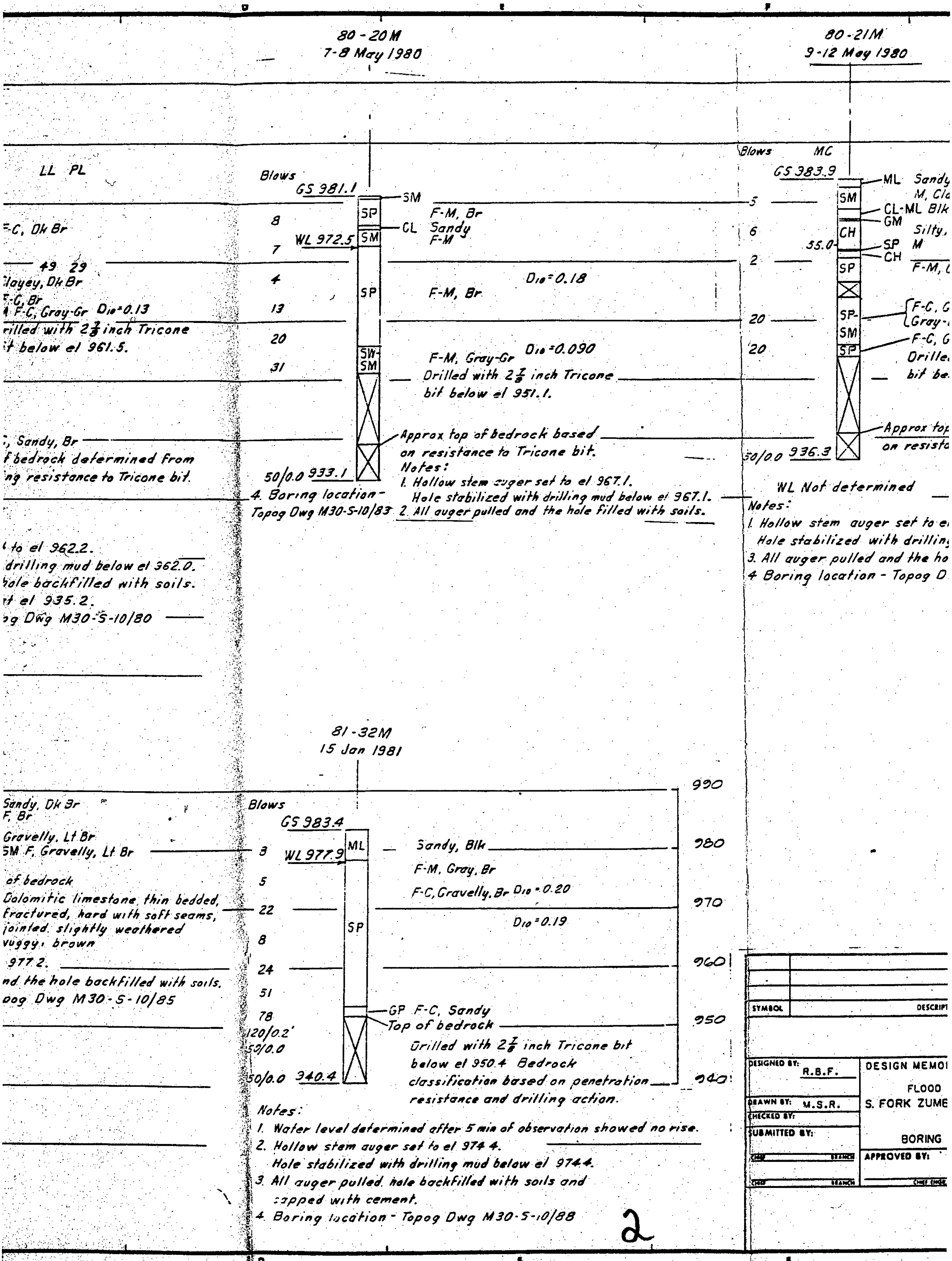
ROCK PROBE SUMMARY
SHEET 3 OF 3

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-3

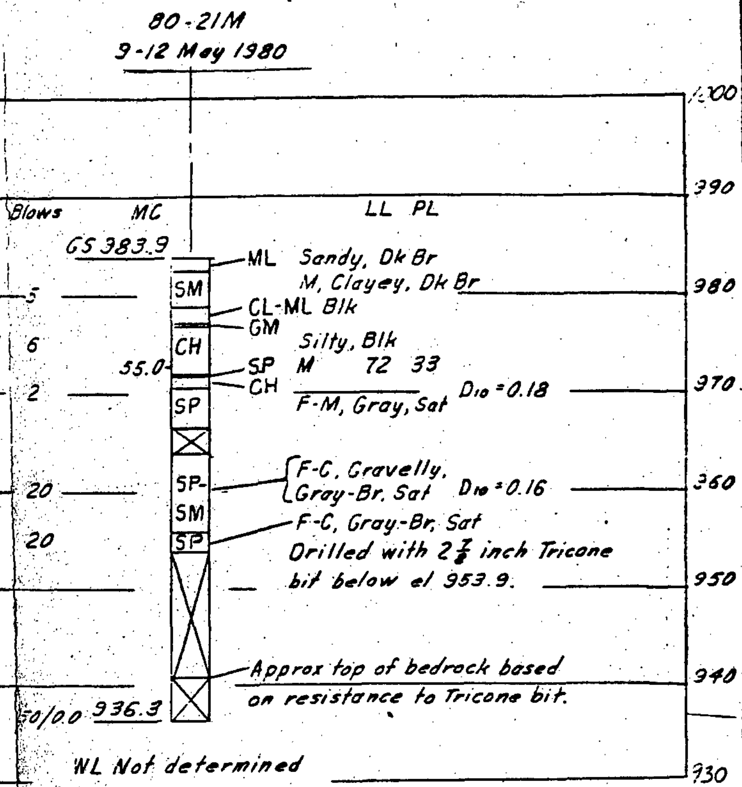
3



80-13M
28 April 1980
Blows MC LL PL
GS 984.4
F, Dk Br
SM
F-M, Dk Br
CL Silty, Sandy
SM F-M, Br
CL Silty, Sandy, Dk Br
SM
SP-SM F-M 32 16
18.6
6 WL 964.6
CL
ML Clayey, Sandy
SM F, Br
ML
SP-SM F-C, Gray-Gr D_{10}=0.15
Drilled with $2\frac{7}{8}$ inch Tricone bit below el 949.4.
SP M, Buff
Approx. top of bedrock
Sandstone, fine, hard,
Poorly cemented, unweathered.
Top of bedrock picked on drilling resistance to Tricone bit and may be as much as 10 feet too low.
177/0.1'
200/0.3' 911.1
Notes:
1. Hollow stem auger set to el 960.4. Hole stabilized with drilling mud below el 960.4.
2. All auger pulled and hole backfilled with soils.
3. Boring location - Topog Dwg M30-S-10/80
80-14M
30 April 1980
Blows MC LL PL
GS 981.2
SM F-C, Dk Br
32.3 49 29
ML Clayey, Dk Br
SP F-C, Br
SW-SM F-C, Gray-Gr D_{10}=0.13
Drilled with $2\frac{7}{8}$ inch Tricone bit below el 961.5.
GM C, Sandy, Br
Top of bedrock determined from drilling resistance to Tricone bit.
6
7
12
15
42
100/0.0 933.0
WL Not determined
Notes:
1. Hollow stem auger set to el 962.2.
2. Hole stabilized with drilling mud below el 962.0.
3. All auger pulled and hole backfilled with soils.
4 Severe water loss at el 935.2.
5 Boring location - Topog Dwg M30-S-10/80
80-22M
12 May 1980
Blows MC LL PL
GS 985.2
ML Sandy, Dk Br
GP F-C, Sandy
ML Sandy, Dk Br
23.0 GP C 36 23
CL Silty, Sandy, Blk-Br, Sat
SP F-M, Sat D_{10}=0.42
GW-GM F-C, Sandy, Gray-Br, Sat
SP M-C, Br, Sat
SP-SM F-C, Br, Sat D_{10}=0.12
Drilled with $2\frac{7}{8}$ inch Tricone bit below el 965.2.
Approx top of bedrock based on resistance to Tricone bit.
14
6
10
24
50/0.0 934.9
WL Not determined
Notes:
1 Hollow stem auger set to el 971.2. Hole stabilized with drilling mud below el 971.2.
2. All auger pulled and hole backfilled with soils.
3. Boring location - Topog Dwg M30-S-10/87
80-23M
13 May 1980
Blows
GS 988.2
ML Sandy, Dk Br
SM F, Br
ML Gravelly, Lt Br
10
18 WL 979.7
977.9
SP-SM F, Gravelly, Lt Br
GM
RQD %Rec
77 100
57 99 967.4
Top of bedrock
Dolomitic limestone, thin bedded, fractured, hard with soft seams, jointed, slightly weathered vuggy, brown
Notes:
1. 6" Casing set to el 977.2.
2. All casing pulled and the hole backfilled with soils.
3. Boring location - Topog Dwg M30-S-10/85
1000
990
980
970
960
950
940
930
920
910
900
990
980
970
960
950
940
930



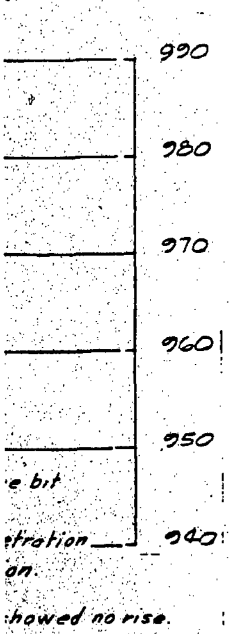
80 - 20M
7-8 May 1980
80 - 21M
9-12 May 1980
LL PL
F-C, Dk Br
49 29
Clayey, Dk Br
F-C, Br
F-C, Gray-Gr D10=0.13
Drilled with 2 7/8 inch Tricone
bit below el 961.5.
Sandy, Br
bedrock determined from
resistance to Tricone bit.
to el 962.2.
drilling mud below el 962.0.
hole backfilled with soils.
at el 935.2.
Topog Dwg M30-S-10/80
Blows
GS 981.1
8
7
4
13
20
31
SM
SP
CL
SM
WL 972.5
SP
SW-SM
F-M, Br
Sandy
F-M
D10=0.18
F-M, Br
F-M, Gray-Gr D10=0.090
Drilled with 2 7/8 inch Tricone
bit below el 951.1.
Approx top of bedrock based
on resistance to Tricone bit.
Notes:
1. Hollow stem auger set to el 967.1.
Hole stabilized with drilling mud below el 967.1.
2. All auger pulled and the hole filled with soils.
50/0.0 933.1
4. Boring location -
Topog Dwg M30-S-10/83
Blows MC
GS 983.9
5
6
2
20
20
55.0
ML Sandy
M, Cl
SM
CL-ML Blk
GM
CH
Silty,
SP M
CH
SP
F-M,
SP-SM
SP
F-C, G
Gray-
F-C, G
Drille
bit be
Approx top
on resista
50/0.0 936.3
WL Not determined
Notes:
1. Hollow stem auger set to e
Hole stabilized with drilling
3. All auger pulled and the ho
4 Boring location - Topog D
81 - 32M
15 Jan 1981
Sandy, Dk Br
F, Br
Gravelly, Lt Br
SM F, Gravelly, Lt Br
of bedrock
Dolomitic limestone, thin bedded,
fractured, hard with soft seams,
jointed slightly weathered
vuggy, brown
977.2.
and the hole backfilled with soils.
Topog Dwg M30-S-10/85
Blows
GS 983.4
3
5
22
8
24
51
78
120/0.2'
50/0.0
50/0.0 940.4
ML
WL 977.9
SP
Sandy, Blk
F-M, Gray, Br
F-C, Gravelly, Br D10=0.20
D10=0.19
GP F-C, Sandy
Top of bedrock
Drilled with 2 7/8 inch Tricone bit
below el 950.4 Bedrock
classification based on penetration
resistance and drilling action.
990
980
970
960
950
940
Notes:
1. Water level determined after 5 min of observation showed no rise.
2. Hollow stem auger set to el 974.4.
Hole stabilized with drilling mud below el 974.4.
3. All auger pulled, hole backfilled with soils and
capped with cement.
4. Boring location - Topog Dwg M30-S-10/88
SYMBOL
DESCRIPT
DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:
APPROVED BY:
DESIGN MEMO
FLOOD
S. FORK ZUMB
BORING
2



967.1.
ud below el 967.1.
filled with soils.

WL Not determined

Notes:
1. Hollow stem auger set to el 964.9.
Hole stabilized with drilling mud below el 964.9.
3. All auger pulled and the hole backfilled with soils.
4 Boring location - Topog Dwg M30-5-10/86



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 PHASE IB, FEATURE
APPENDIX - B
FLOOD CONTROL - MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER - ROCHESTER, MINNESOTA
ROCHESTER
BORING LOGS 80-13M THRU 81-32M

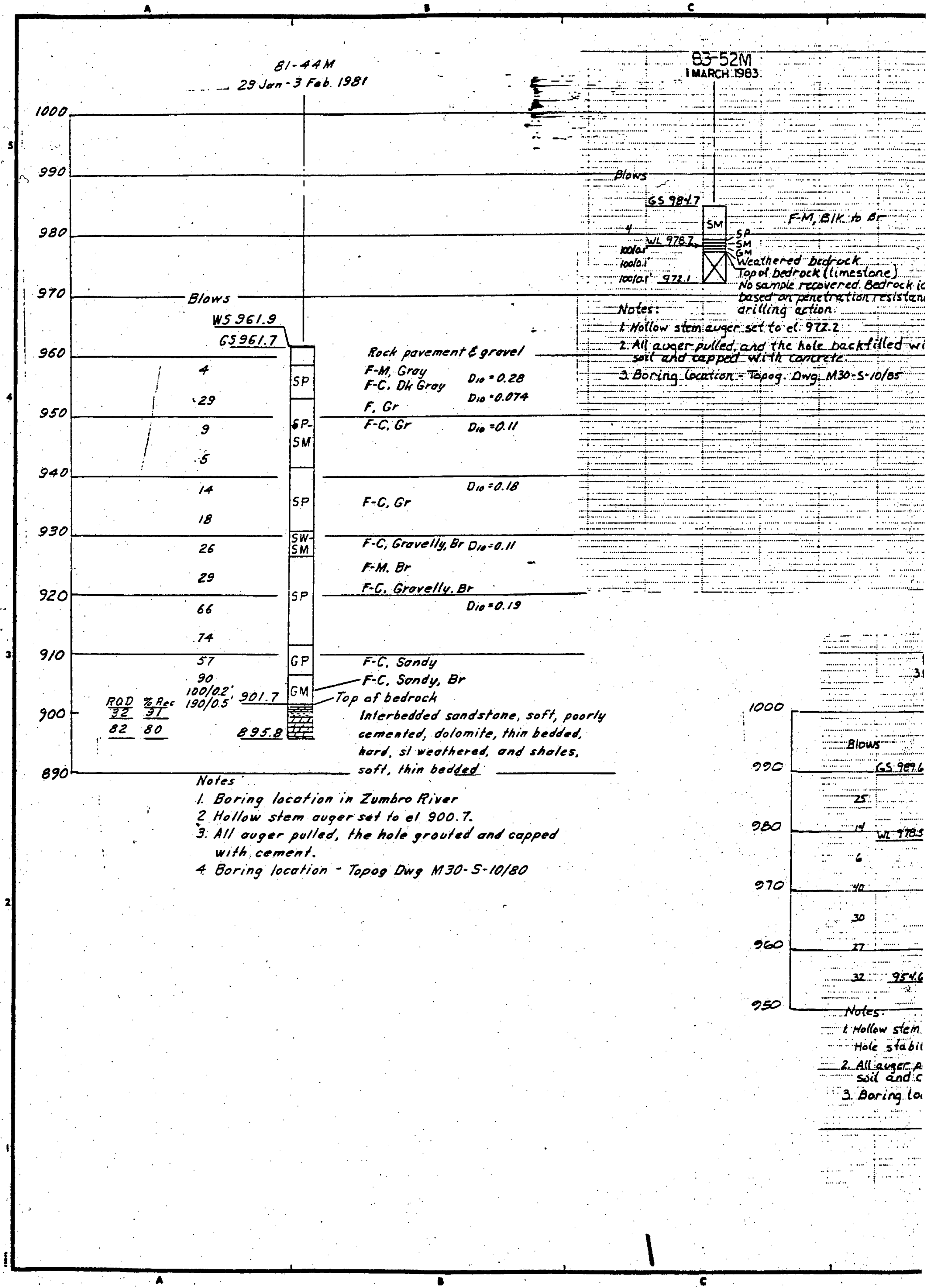
APPROVED BY:
CHIEF ENGR. DIVISION

DATE: JANUARY 1987

SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER
SHEET OF

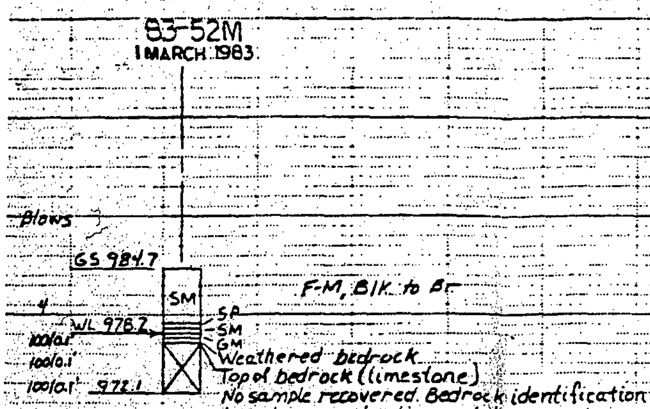
3

PLATE B-4

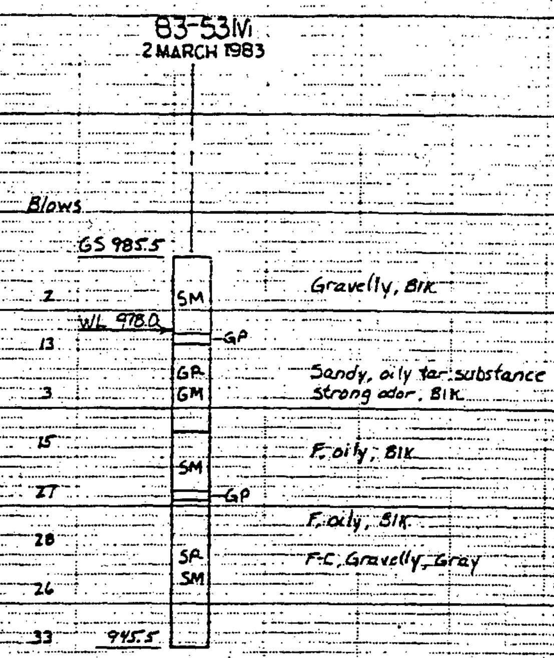


81-44M
29 Jan-3 Feb. 1981
1000
990
980
970
960
950
940
930
920
910
900
890
Blows
WS 961.9
GS 961.7
4
29
9
5
14
18
26
29
66
74
57
90
100/0.2'
190/0.5'
901.7
895.8
RQD
32
82
% Rec
91
80
SP
SP-SM
SP
SW-SM
SP
GP
GM
Rock pavement & gravel
F-M, Gray
F-C, Dk Gray
F, Gr
F-C, Gr
F-C, Gr
F-C, Gravelly, Br
F-M, Br
F-C, Gravelly, Br
F-C, Sandy
F-C, Sandy, Br
Top of bedrock
Interbedded sandstone, soft, poorly cemented, dolomite, thin bedded, hard, sl weathered, and shales, soft, thin bedded
D10 = 0.28
D10 = 0.074
D10 = 0.11
D10 = 0.18
D10 = 0.11
D10 = 0.19
Notes
1. Boring location in Zumbro River
2. Hollow stem auger set to el 900.7.
3. All auger pulled, the hole grouted and capped with cement.
4. Boring location - Topog Dwg M30-S-10/80
83-52M
1 MARCH 1983
Blows
GS 984.7
4
WL 978.7
100/0.5'
100/0.1'
100/0.1'
972.1
SM
SP
SM
GM
F-M, Blk to Br
Weathered bedrock
Top of bedrock (limestone)
No sample recovered. Bedrock ic
based on penetration resistan
drilling action.
Notes:
1. Hollow stem auger set to el. 972.2
2. All auger pulled, and the hole backfilled wi
soil and capped with concrete.
3. Boring location - Topog. Dwg. M30-S-10/85
1000
990
980
970
960
950
Blows
GS 989.6
25
14
WL 978.5
6
40
30
27
32
954.6
Notes:
1. Hollow stem
Hole stabil
2. All auger p
soil and c
3. Boring lo

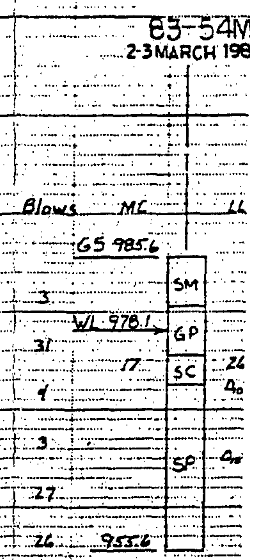
C D E F



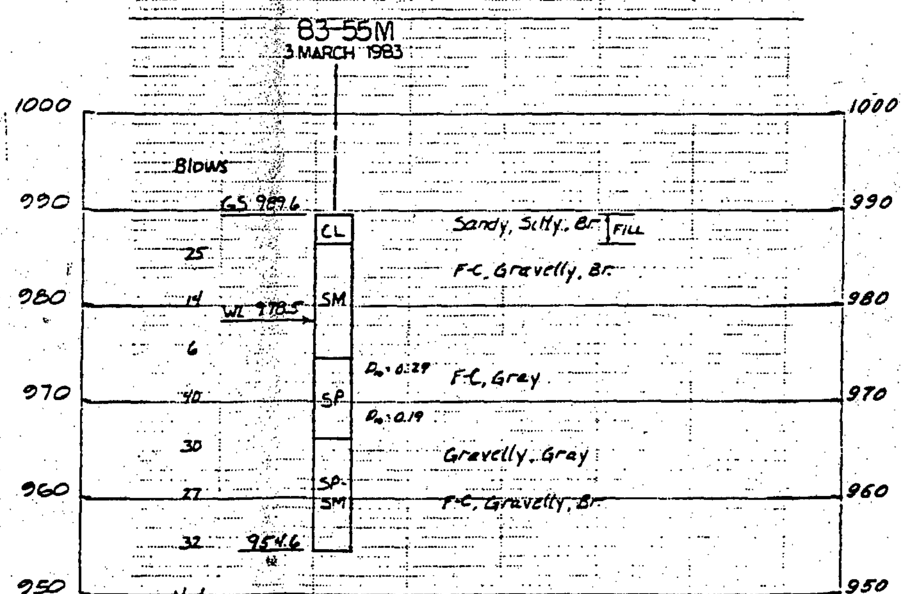
Notes:
1. Hollow stem auger set to el. 972.2
2. All auger pulled, and the hole backfilled with soil and capped with concrete.
3. Boring location - Topog. Dwg. M30-S-10/85



Notes:
1. Hollow stem auger set to el. 964.0
Hole stabilized with drilling mud below el. 964.0
2. Drilling fluid loss between el 960.5 and 955.5
3. All auger pulled, and the hole backfilled with soil and capped with concrete.
4. Boring location - Topog. Dwg. M30-S-10/85



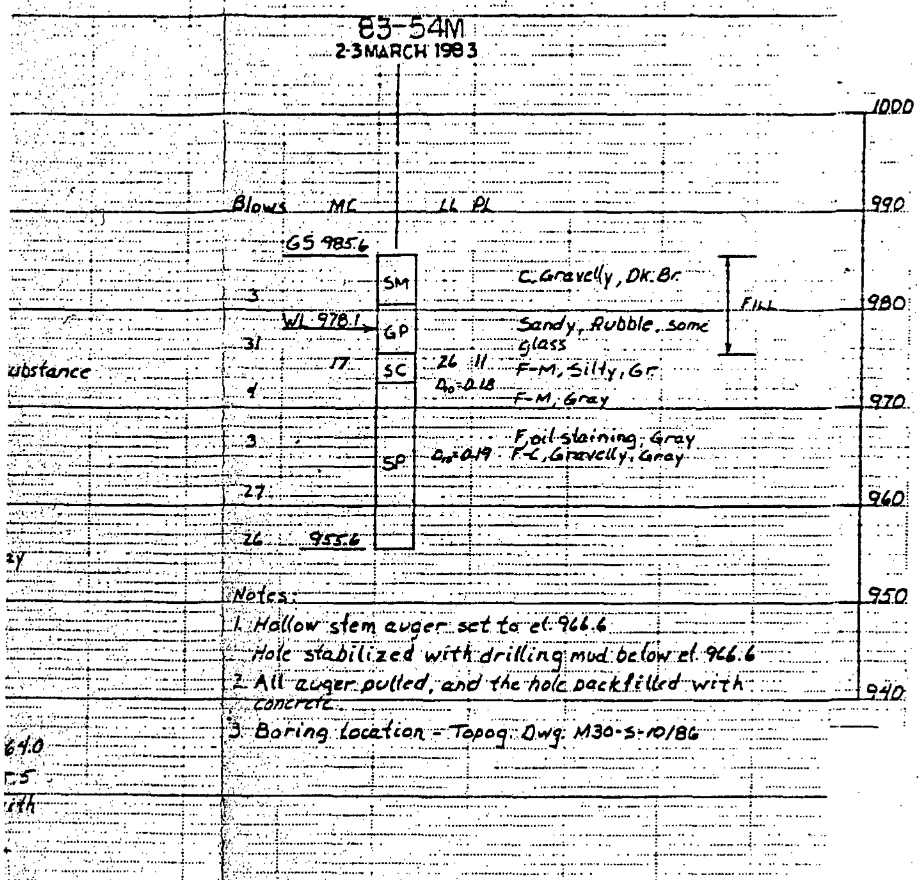
Notes:
1. Hollow stem auger
Hole stabilized wi
2. All auger pulled, a
concrete.
3. Boring Location -



Notes:
1. Hollow stem auger set to el. 974.6
Hole stabilized with drilling mud below el. 974.6
2. All auger pulled and the hole backfilled with soil and capped with concrete
3. Boring location - Topog. Dwg. M30-S-10/86

SYMBOL	
DESIGNED BY:	R.B.F
DRAWN BY:	M.S.R
CHECKED BY:	
SUBMITTED BY:	

C D E F



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

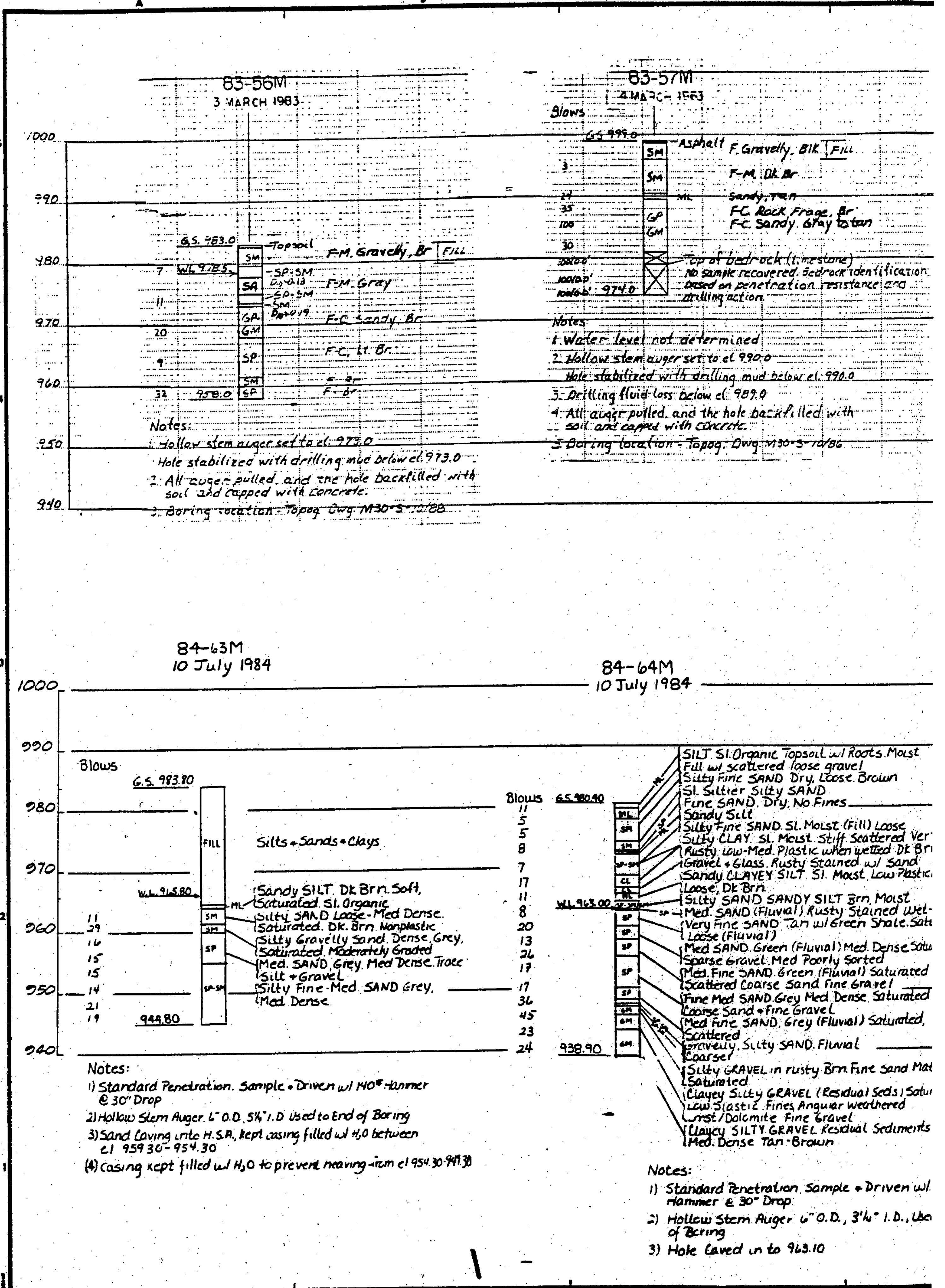
DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 PHASE IB, FEATURE APPENDIX - B
FLOOD CONTROL - MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER - ROCHESTER, MINNESOTA
ROCHESTER
BORING LOGS 81-44M THRU 83-55M

APPROVED BY:
DATE: JANUARY 1987
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER
SHEET OF

3

PLATE B-5



83-56M
3 MARCH 1983
1000
990
G.S. 983.0
Topsoil
F-M Gravelly, Br FILL
W.L. 978.5
SP-SM
SA
F-M Gray
SP-SM
SM
GP
GM
F-C Sandy, Br
SP
F-C, Lt. Br
SM
SP
F-Br
958.0
Notes:
1. Hollow stem auger set to el. 973.0
Hole stabilized with drilling mud below el. 973.0
2. All auger pulled and the hole backfilled with soil and capped with concrete.
3. Boring location - Topog. Dwg. M30-S-10/88
83-57M
4 MARCH 1983
Blows
G.S. 999.0
Asphalt
F. Gravelly, Blk. FILL
SM
F-M, Dk. Br
ML
Sandy, Tan
GP
GM
F-C Rock Frags, Br
F-C Sandy, Gray to tan
Top of bedrock (limestone)
No sample recovered. Bedrock identification based on penetration resistance and drilling action.
974.0
Notes
1. Water level not determined
2. Hollow stem auger set to el. 990.0
Hole stabilized with drilling mud below el. 990.0
3. Drilling fluid loss below el. 989.0
4. All auger pulled and the hole backfilled with soil and capped with concrete.
5. Boring location - Topog. Dwg. M30-S-10/86
84-63M
10 July 1984
1000
990
980
970
960
950
940
Blows
G.S. 983.80
FILL
Silts + Sands + Clays
W.L. 965.80
ML
Sandy SILT. Dk Brn. Soft, Saturated. Sl. Organic
SM
Silty SAND Loose-Med Dense. Saturated. Dk. Brn. Nonplastic
SP
Silty Gravelly Sand. Dense. Grey, Saturated. Moderately Graded
Med. SAND. Grey. Med Dense. Trace Silt + Gravel
SP-SM
Silty Fine-Med. SAND Grey, Med. Dense
944.80
Notes:
1) Standard Penetration. Sample + Driven w/ 140# Hammer @ 30" Drop
2) Hollow Stem Auger. 6" O.D. 5¼" I.D Used to End of Boring
3) Sand Caving into H.S.A. kept casing filled w/ H_2O between el 959.30-954.30
(4) Casing kept filled w/ H_2O to prevent heaving from el 954.30-944.30
84-64M
10 July 1984
Blows
G.S. 980.90
SILT. Sl. Organic Topsoil w/ Roots. Moist
Fill w/ scattered loose gravel
Silty Fine SAND Dry, Loose. Brown
Sl. Siltier Silty SAND
Fine SAND. Dry, No Fines
Sandy Silt
Silty Fine SAND. Sl. Moist (Fill) Loose
Silty CLAY. Sl. Moist. Stiff Scattered
Rusty. Low-Med. Plastic when wetted Dk Br
Gravel + Glass. Rusty Stained w/ Sand
Sandy CLAYEY SILT. Sl. Moist. Low Plastic
Loose, Dk Brn
W.L. 963.00
Silty SAND SANDY SILT Brn. Moist
Med. SAND (Fluvial) Rusty Stained Wet
Very Fine SAND Tan w/ Green Shale. Sat
Loose (Fluvial)
Med SAND. Green (Fluvial) Med. Dense Satu
Sparse Gravel. Med Poorly Sorted
Med. Fine SAND. Green (Fluvial) Saturated
Scattered Coarse Sand Fine Gravel
Fine Med SAND. Grey Med Dense. Saturated
Coarse Sand + Fine Gravel
Med Fine SAND, Grey (Fluvial) Saturated, Scattered
Gravelly, Silty SAND. Fluvial
Coarse
Silty GRAVEL in rusty Brn. Fine Sand Mat
Saturated
Clayey Silty GRAVEL (Residual Seds) Satu
Low Plastic Fines Angular weathered
Lmst/Dolomite Fine Gravel
Clayey SILTY GRAVEL Residual Sediments
Med. Dense Tan-Brown
938.90
Notes:
1) Standard Penetration Sample + Driven w/ Hammer @ 30" Drop
2) Hollow Stem Auger 6" O.D., 3¼" I.D., Used of Boring
3) Hole Caved in to 963.10

C D E F

57M
1983

Asphalt F. Gravelly, Blk FILL
F-M, Dk Br
ML Sandy, Tan
F-C Rock Frags, Br
F-C Sandy, Gray to tan
Top of bedrock (limestone)
No sample recovered. Bedrock identification based on penetration resistance and drilling action.

...t determined
...ger set to el. 990.0
...ith drilling mud below el. 990.0
...s below el. 989.0
... and the hole backfilled with ... with concrete.
...n - Topog. Dwg. M30-5-10/86

83-61M
8 MARCH 1983

Blows

G.S. 996.1

6
44
100/3"
100/0.0
100/00 976.1

GM
GP-GM
GM

Topsoil Sandy FILL
SM
GP-GM F-C, Sandy, Br to Gray
F-C Sandy, Rubble
Weathered bedrock
Top of bedrock (limestone)
No sample recovered. Bedrock identification based on penetration resistance and drilling action.

Notes:
1. Water level not determined
2. Hollow stem auger set to el. 956.1.
Hole stabilized with drilling mud below el. 956.1
3. All auger pulled and the hole backfilled with soil and capped with concrete.
4. Boring location - Topog. Dwg. M30-5-10/93

84-62M
10 July 1984

Blows

G.S. 983.65

15
11
6
9
8
9
8
9
8
27
27

ML
ML
ML
SC SM
SC SM
SM
OH
ML
SP

W.L. 965.15
957.15

Notes:
1) Standard Penetration Sample Hammer @ 30" Drop
2) Hollow Stem Auger, 6" O.D. End of Boring.

84-65M
16 Oct. 1984

M
984

1000
990
980
970
960
950
940

SILT Sl. Organic Topsoil w/ Roots Moist
Fill w/ scattered loose gravel
Silty Fine SAND Dry, Loose, Brown
Sl. Siltier Silty SAND
Fine SAND, Dry, No Fines
Sandy Silt
Silty Fine SAND Sl. Moist (Fill) Loose
Silty CLAY Sl. Moist Stiff Scattered Vert.
Rusty Low-Med. Plastic when wetted Dk Brn
Gravel + Glass, Rusty Stained w/ Sand
Sandy CLAYEY SILT Sl. Moist Low Plasticity
Loose, Dk Brn
Silty SAND SANDY SILT Brn, Moist
Med. SAND (Fluvial) Rusty Stained Wet-Sat
Very Fine SAND Tan w/ Green Shale. Saturated
Loose (Fluvial)
Med SAND Green (Fluvial) Med. Dense Saturated
Sparse Gravel, Med Poorly Sorted
Med. Fine SAND Green (Fluvial) Saturated
Scattered Coarse Sand Fine Gravel
Fine Med SAND Grey Med Dense Saturated
Coarse Sand + Fine Gravel
Med Fine SAND Grey (Fluvial) Saturated, Scattered
Gravelly Silty SAND Fluvial
Coarser
Silty GRAVEL in rusty Brn Fine Sand Matrix
Saturated
Clayey Silty GRAVEL (Residual Seds) Saturated
Low Plastic Fines Angular Weathered
...rst/Dolomite Fine Gravel
Clayey SILTY GRAVEL Residual Sediments
Med. Dense Tan-Brown

Notes:
Standard Penetration Sample + Driven w/ 140# Hammer @ 30" Drop
Hollow Stem Auger 6" O.D., 3¼" I.D., Used to end of Boring
Hole Caved in to 963.10

Blows W.C. LL P.L

GS 983.8

8
15 22 16
W.L. 974.1
6
5
8
36
40 953.8

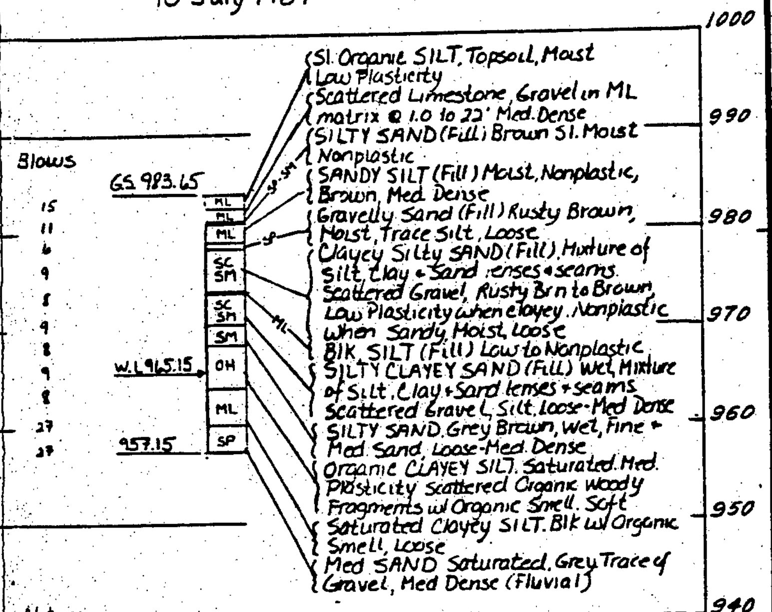
SP
SP-SM
SP-SM
SP
GP-GM
SP

F-C Gravelly, Br. Fill
SC-SM F-C Silty, Dk. Gray, D_{10} = 0.002
F-M, Br.-Gray, D_{10} = 0.14
F-M, Silty, Gray
Scattered ML Laminations
CL Silty, Blk.
SM F-M Dk. Gray
F-M, Gray
GP-SP-SM Gravelly, Sand seam.
Silty, Sandy, Tan
F-M, Tan

Notes:
1. Silver Lake water surface = 974.1
2. Hollow Stem Auger set to elev. 966.3
Hole stabilized with drilling mud below elev 966.3
3. All auger pulled and hole backfilled with soils and capped with cement.
4. Boring location - Topog Drg. M30-5-10/84.

SYMBOL	
DESIGNED BY: R.B.F.	DESI...
DRAWN BY: M.S.R.	S. FO...
CHECKED BY:	
SUBMITTED BY:	
	APPRO...

84-62M
10 July 1984



(Sl. Organic SILT, Topsoil, Moist, Low Plasticity
(Scattered Limestone, Gravel in ML matrix @ 1.0 to 2.2' Med. Dense
(SILTY SAND (Fill) Brown Sl. Moist Nonplastic
(SANDY SILT (Fill) Moist, Nonplastic, Brown, Med. Dense
(Gravelly Sand (Fill) Rusty Brown, Moist, Trace Silt, Loose
(Clayey Silty SAND (Fill), Mixture of Silt, Clay + Sand lenses + seams. Scattered Gravel, Rusty Brn to Brown, Low Plasticity when clayey. Nonplastic when Sandy, Moist, Loose
(Blk SILT (Fill) Low to Nonplastic
(SILTY CLAYEY SAND (Fill) Wet, Mixture of Silt, Clay + Sand lenses + seams. Scattered Gravel, Silt, Loose-Med Dense
(SILTY SAND, Grey Brown, Wet, Fine + Med. Sand, Loose-Med. Dense
(Organic CLAYEY SILT, Saturated, Med. Plasticity Scattered Organic Woody Fragments w/ Organic Smell. Soft
(Saturated Clayey SILT. Blk w/ Organic Smell, Loose
(Med SAND Saturated, Grey Trace of Gravel, Med Dense (Fluvial)

Notes:
1) Standard Penetration Sample + Driven w/ 140# Hammer @ 30" Drop
2) Hollow Stem Auger, 6" O.D. 3 1/4" I.D. Used to End of Boring.

SYMBOL	DESCRIPTION	DATE	APPROVAL

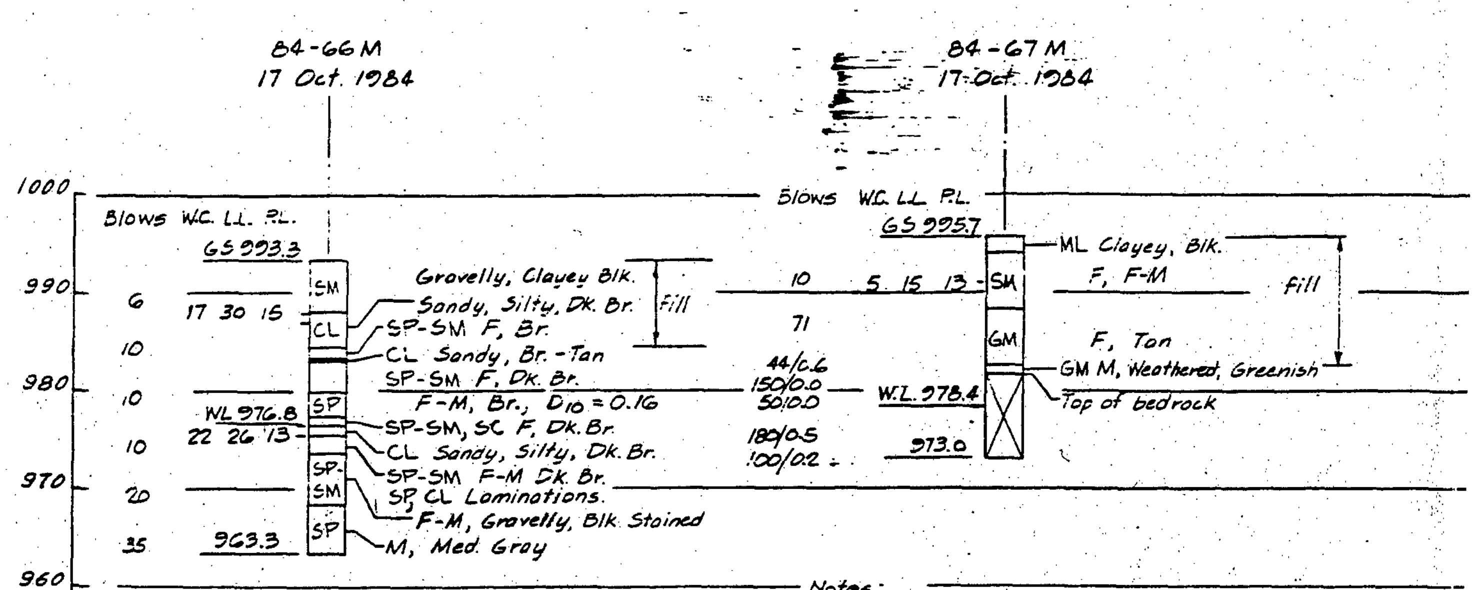
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 PHASE IB, FEATURE APPENDIX – B
FLOOD CONTROL – MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER – ROCHESTER, MINNESOTA
ROCHESTER
BORING LOGS 83-56M THRU 84-65M

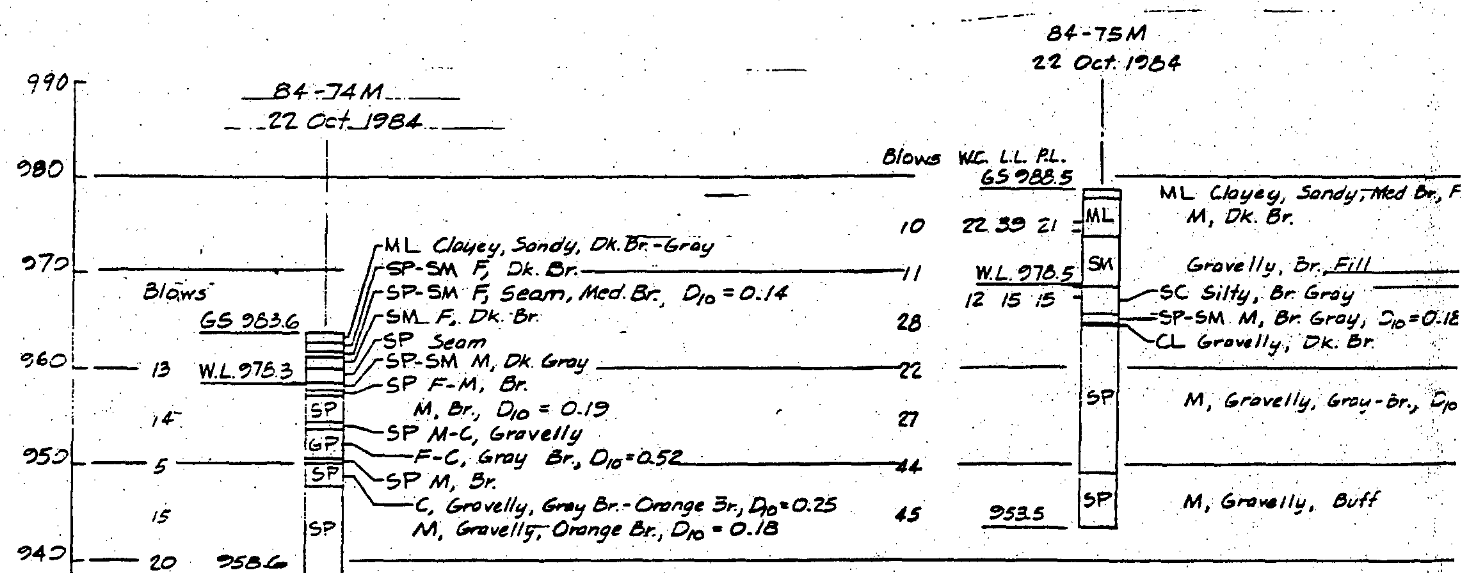
APPROVED BY:
DATE: JANUARY 1987
SCALE AS SHOWN
DRAWING NUMBER
3
SHEET OF

PLATE B-6



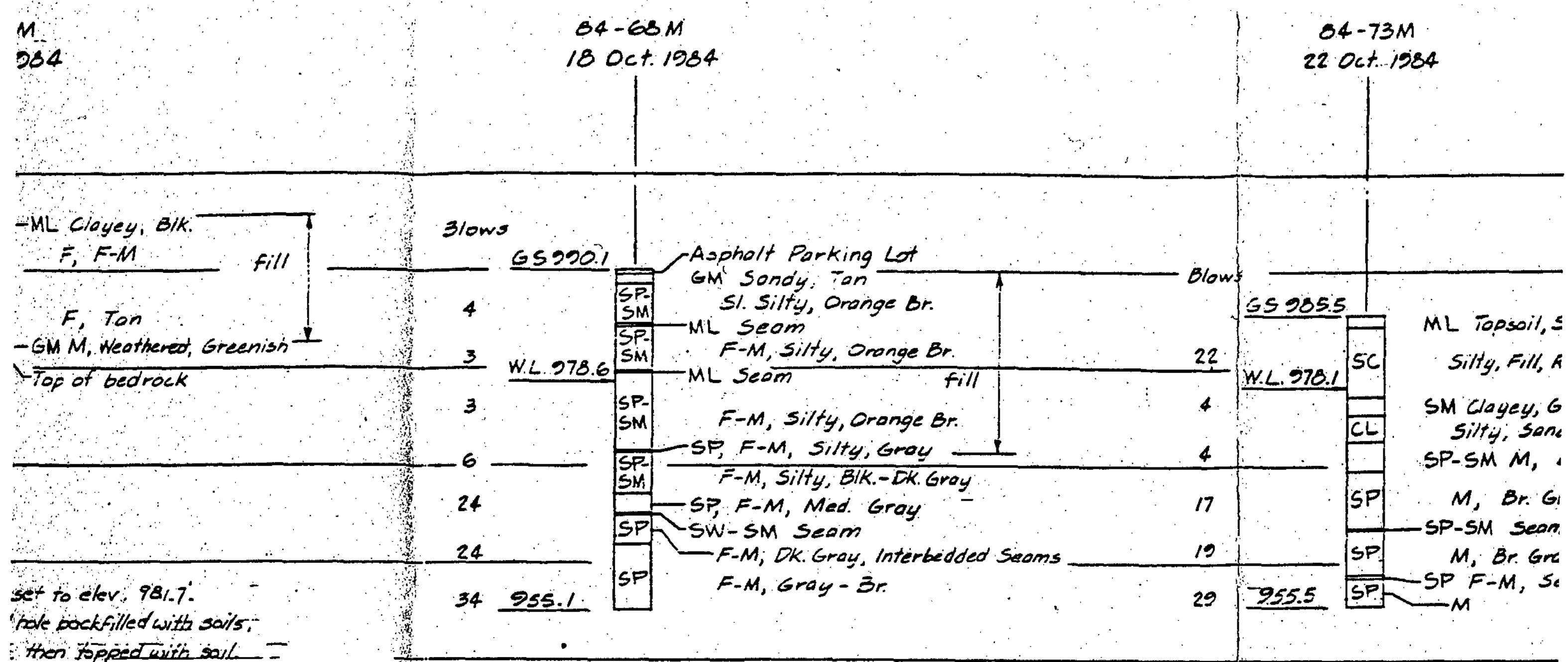
Notes:
1. Hollow Stem Auger set to elev. 981.7.
2. All auger pulled and hole backfilled with soils, capped with cement, then topped with soil.
80% water loss @ 18.0'.
3. Boring location - Topog. Drg. M30-5-10/86.

Notes:
1. Hollow Stem Auger set to elev. 974.3.
Hole stabilized with drilling mud below elev. 973.3.
2. All auger pulled and hole backfilled with soils and capped with cement.
3. Boring location - Topog Drg. M30-5-10/85.



Notes:
1. W.S. of river adjacent to boring = 978.2
2. Hollow Stem Auger set to elev. 967.1
Hole stabilized with drilling mud below elev. 973.6
3. All auger pulled and hole backfilled with soils and capped with cement.
4. Boring location - Topog Drg. M30-5-10/88.

Notes:
1. W.S. of river adjacent to boring = 978.26
2. Hollow Stem Auger set to elev. 974.0
Hole stabilized with drilling mud below elev. 97
3. All auger pulled and hole backfilled with soils and capped with cement.
4. Boring location - Topog Drg. M30-5-10/87



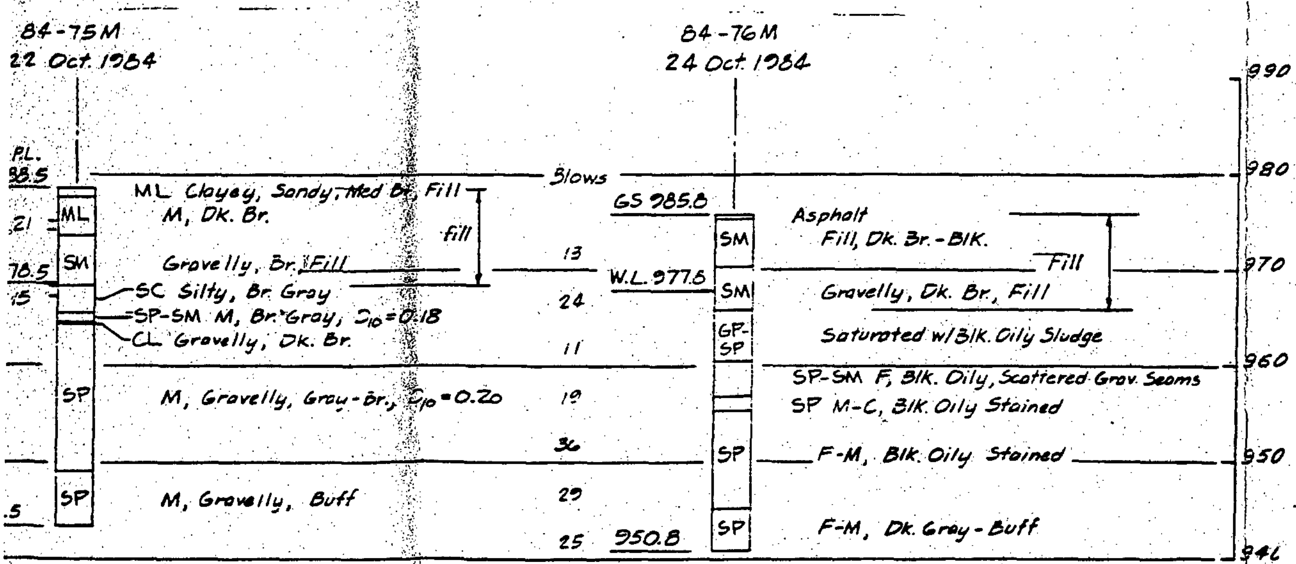
set to elev. 981.7.
hole backfilled with soils,
then topped with soil
18.0'.
og. Drg. M30-S-10/86.

Notes:

1. W.S. of river adjacent to boring = 978.8
2. Hollow Stem Auger set to elev. 976.1. Hole stabilized with drilling mud below elev. 975.1
3. All auger pulled and hole backfilled with soils and capped with cement.
4. Boring location - Topog Drg. M30-S-10/86.

Notes:

1. Hollow Stem Auger set to elev.
Hole stabilized with drilling mud.
2. Boring location - Topog Drg. M3



of river adjacent to boring = 978.26
Stem Auger set to elev. 974.0
stabilized with drilling mud below elev. 973.5
ger pulled and hole backfilled with soils
capped with cement.
g. location - Topog Drg. M30-S-10/87

Notes:

1. W.S. of river adjacent to boring = 978.48.
2. Hollow Stem Auger set to elev. 966.3. Hole stabilized with drilling mud below elev. 959.9.
3. All auger pulled and hole backfilled with soils, and capped with cement.
4. Samples saturated with black oily sludge.
5. Boring location - Topog Drg. M30-S-10/85

SYMBOL	
DESIGNED BY: R.B.F.	DESIGI
DRAWN BY: M.S.R.	S. FOR
CHECKED BY:	
SUBMITTED BY:	APPROV

2

84-73M
22 Oct. 1984

Blows				Elev.
	GS 985.5		ML Topsoil, Sandy, Fill	1000
22	W.L. 978.1	SC	Silty, Fill, Rusty Br., Dk. Br. Fill	990
4		CL	SM Clayey, Green Br. w/ Blk. Mottling Scat. Silty, Sandy	980
4			SP-SM M, Dk. Gray	970
17		SP	M, Br. Gray	
			SP-SM Seam	
19		SP	M, Br. Gray	960
29	955.5	SP	SP F-M, Seam; M	950

Notes:
1. Hollow Stem Auger set to elev 971.0.
Hole stabilized with drilling mud below elev 975.5.
2. Boring location - Topog Drg. M30-5-10/86.

Lot
e Br.
nge Br.
Fill
nge Br.
Gray
-Dk. Gray
ray
nterbedded Seams

78.8
Hole
975.1
Soils
0/86.

k. Br. - Blk.
Fill
lly, Dk. Br., Fill
pted w/Blk. Oily Sludge
F, Blk. Oily, Scattered Grav. Seams
, Blk. Oily Stained
Blk. Oily Stained
Dk. Gray - Buff

990
980
970
960
950
946

boring = 978.48.
elev. 966.3.
mud below elev. 959.9.
backfilled with soils,
black oily sludge.
g. M30-5-10/85

SYMBOL	DESCRIPTION	DATE	APPROVAL

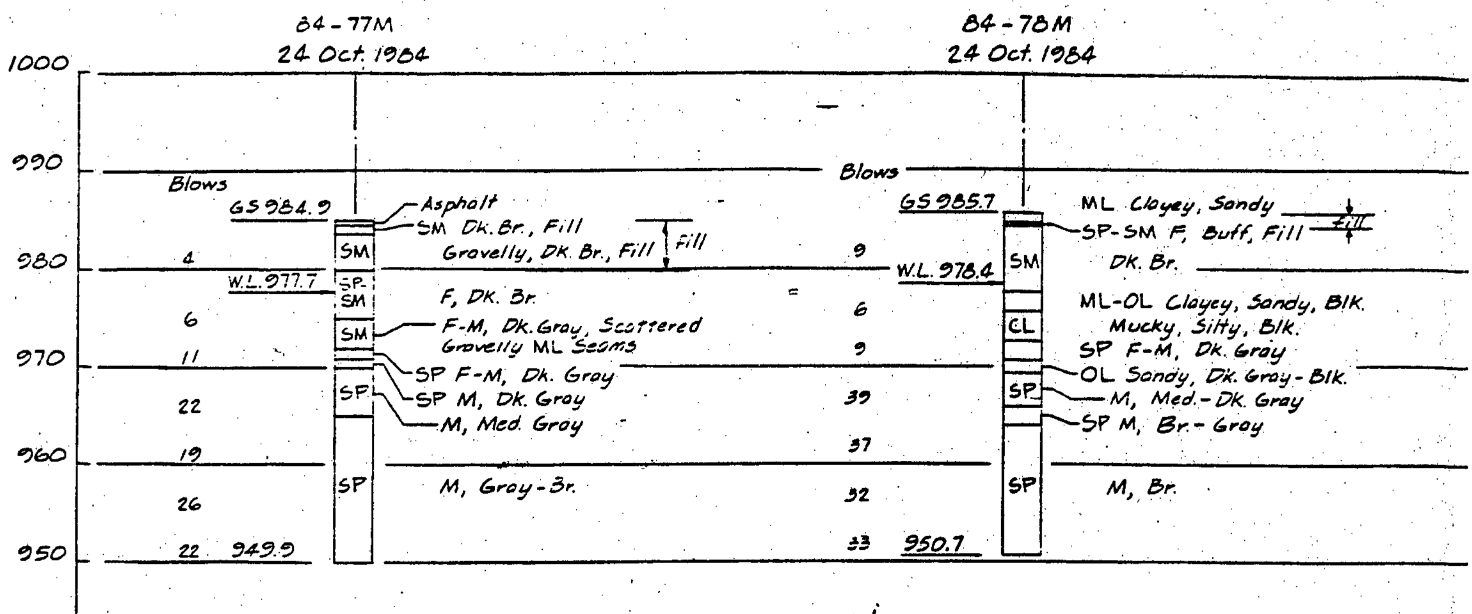
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 PHASE IB, FEATURE
APPENDIX - B
FLOOD CONTROL - MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER - ROCHESTER, MINNESOTA
ROCHESTER
BORING LOGS 84-66M THRU 84-76M

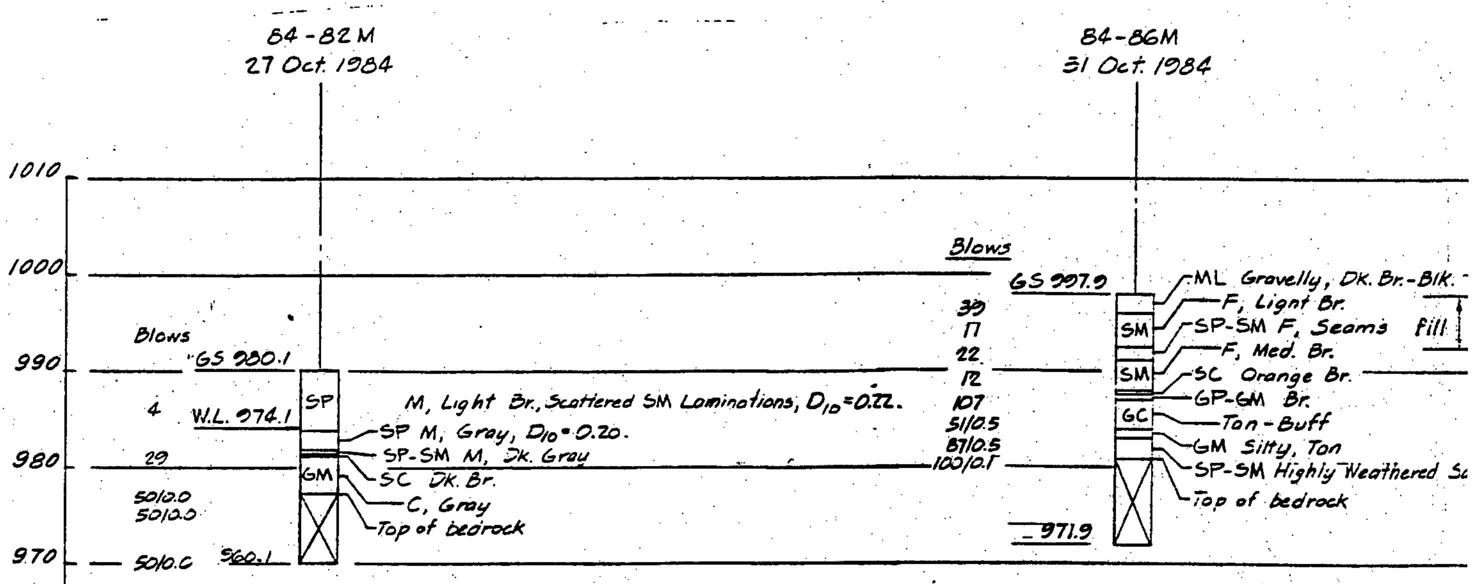
APPROVED BY:
DATE: JANUARY 1987
SCALE: AS SHOWN
DRAWING NUMBER
3
SHEET OF

PLATE B-7



Notes:
1. Hollow Stem Auger set to elev. 970.4
Hole stabilized with drilling mud below elev. 969.9.
2. All auger pulled and hole backfilled with soils and capped with cement.
3. Boring location - Topog Drg. M30-S-10/86

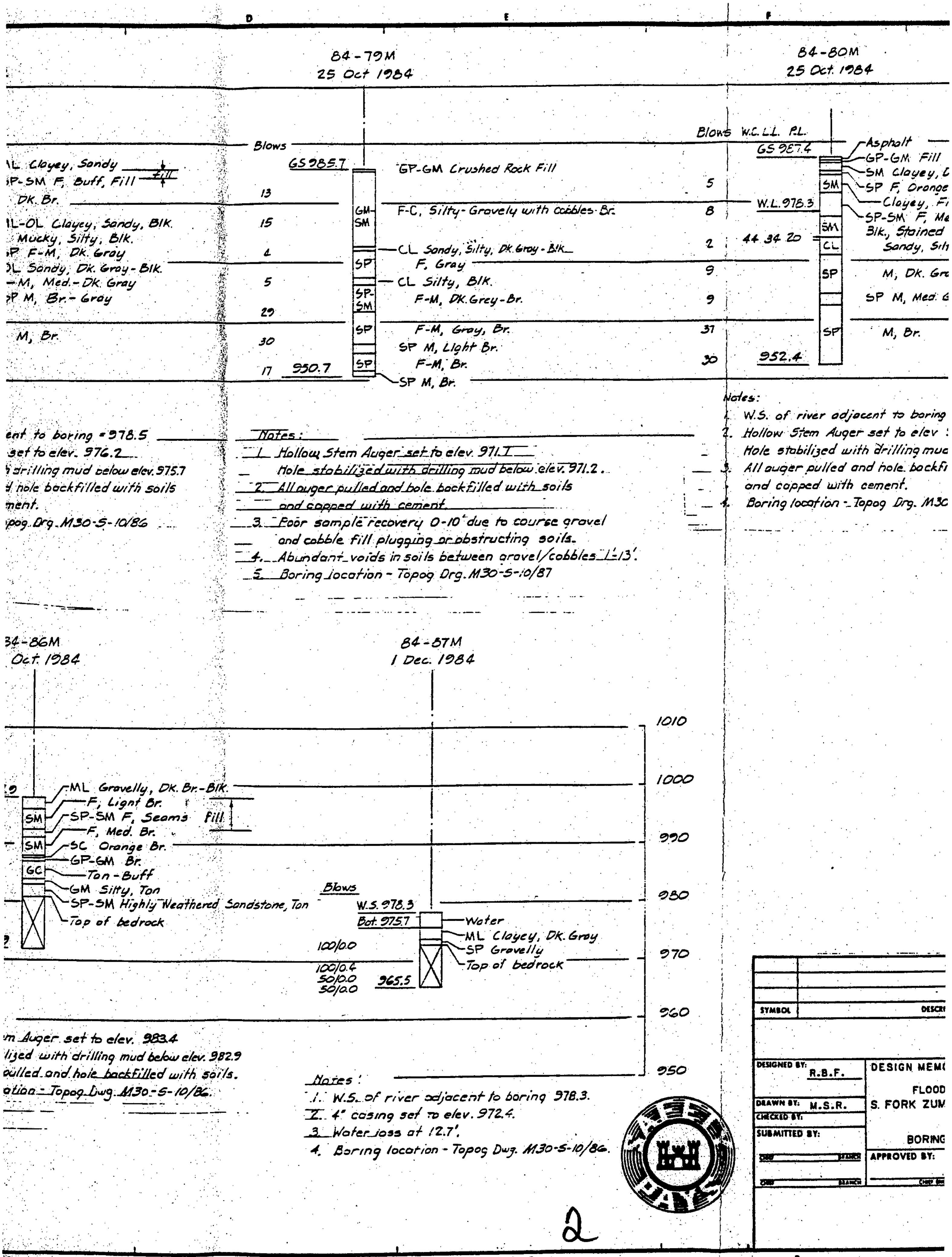
Notes:
1. W.S. of river adjacent to boring = 978.5
2. Hollow Stem Auger set to elev. 976.2
Hole stabilized with drilling mud below elev. 975.7
3. All auger pulled and hole backfilled with soils and capped with cement.
4. Boring location - Topog Drg. M30-S-10/86

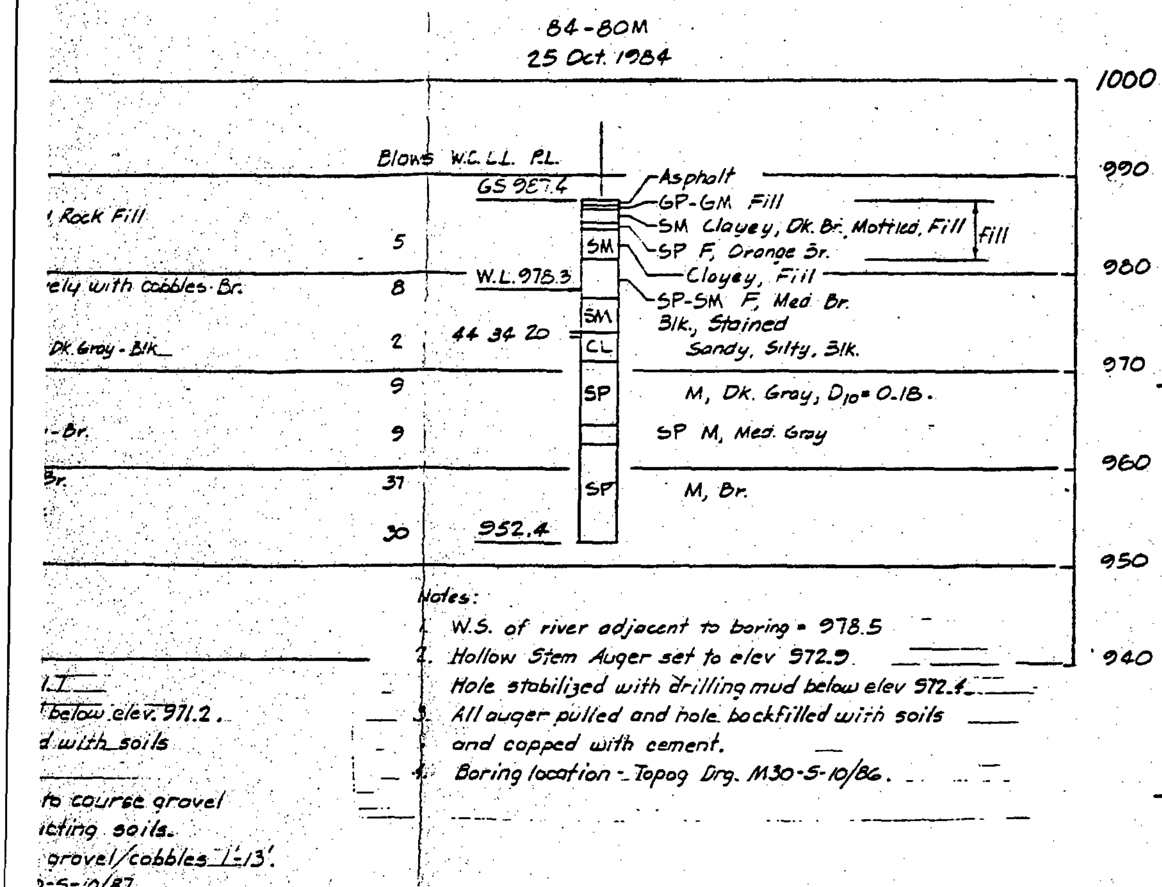


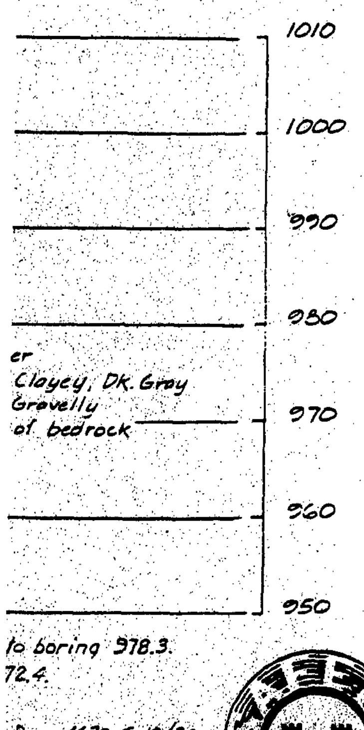
960
950

Notes:
1. W.S. of Silver Lake adjacent to boring = 973.98
2. Hollow Stem Auger set to elev. 970.6.
Hole stabilized with drilling mud below elev. 970.1.
3. Boring location - Topog Drg. M30-S-10/85.

Notes:
1. Hollow Stem Auger set to elev. 983.4
Hole stabilized with drilling mud below elev. 982.9
2. All auger pulled and hole backfilled with soils.
3. Boring location - Topog Dwg. M30-S-10/86.


84-79M
25 Oct 1984
Blows
GS 985.7
GP-GM Crushed Rock Fill
13
15
4
5
29
30
17
950.7
GM-SM
SP
SP-SM
SP
SP
F-C, Silty-Gravely with cobbles-Br.
CL Sandy, Silty, Dk. Gray-Blk
F, Gray
CL Silty, Blk.
F-M, Dk. Grey-Br.
F-M, Gray, Br.
SP M, Light Br.
F-M, Br.
SP M, Br.
Notes:
1. Hollow Stem Auger set to elev. 971.7
Hole stabilized with drilling mud below elev. 971.2.
2. All auger pulled and hole backfilled with soils and capped with cement.
3. Poor sample recovery 0-10' due to course gravel and cobble fill plugging or obstructing soils.
4. Abundant voids in soils between gravel/cobbles 1'-13'.
5. Boring location - Topog Drg. M30-5-10/87
ML Clayey, Sandy
SP-SM F, Buff, Fill
Fill
Dk. Br.
ML-OL Clayey, Sandy, Blk.
Mucky, Silty, Blk.
SP F-M, Dk. Gray
OL Sandy, Dk. Gray-Blk.
-M, Med.-Dk. Gray
SP M, Br.-Gray
M, Br.
ent to boring = 978.5
set to elev. 976.2
drilling mud below elev. 975.7
hole backfilled with soils
ment.
pog Drg. M30-5-10/86
84-80M
25 Oct. 1984
Blows W.C. L.L. P.L.
GS 987.4
5
8
2
9
9
31
30
W.L. 978.3
44 34 20
952.4
SM
SM
CL
SP
SP
Asphalt
GP-GM Fill
SM Clayey,
SP F, Orange
Clayey, F
SP-SM F, Me
Blk., Stained
Sandy, Sil
M, Dk. Gr
SP M, Med.
M, Br.
Notes:
1. W.S. of river adjacent to boring
2. Hollow Stem Auger set to elev
Hole stabilized with drilling mud
3. All auger pulled and hole backfi
and capped with cement.
4. Boring location - Topog Drg. M30
84-86M
Oct. 1984
ML Gravelly, Dk. Br.-Blk.
F, Light Br.
SP-SM F, Seams
Fill
F, Med. Br.
SC Orange Br.
GP-GM Br.
Tan-Buff
GM Silty, Tan
SP-SM Highly Weathered Sandstone, Tan
Top of bedrock
SM
SM
GC
m Auger set to elev. 983.4
lized with drilling mud below elev. 982.9
pulled and hole backfilled with soils.
ation - Topog Dwg. M30-5-10/86.
84-87M
1 Dec. 1984
Blows
W.S. 978.3
Bot. 975.7
Water
ML Clayey, Dk. Gray
SP Gravelly
Top of bedrock
100/0.0
100/0.4
50/0.0
50/0.0
965.5
1010
1000
990
980
970
960
950
Notes:
1. W.S. of river adjacent to boring 978.3.
2. 4" casing set to elev. 972.4.
3. Water loss at 12.7'.
4. Boring location - Topog Dwg. M30-5-10/86.
SYMBOL
DESCR
DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:
APPROVED BY:
DESIGN MEM
FLOOD
S. FORK ZUM
BORING
2





SYMBOL	DESCRIPTION	DATE	APPROVAL

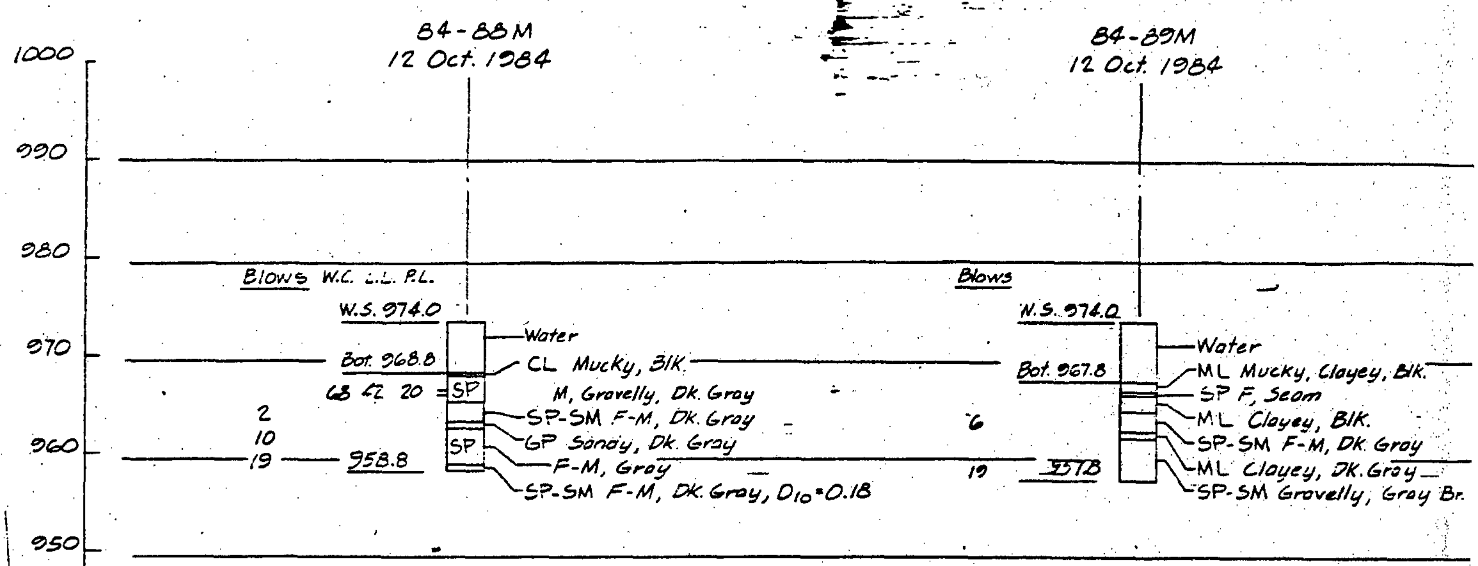
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 PHASE IB. FEATURE
APPENDIX - B
FLOOD CONTROL - MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER - ROCHESTER, MINNESOTA
ROCHESTER
BORING LOGS 84-77M THRU 84-87M

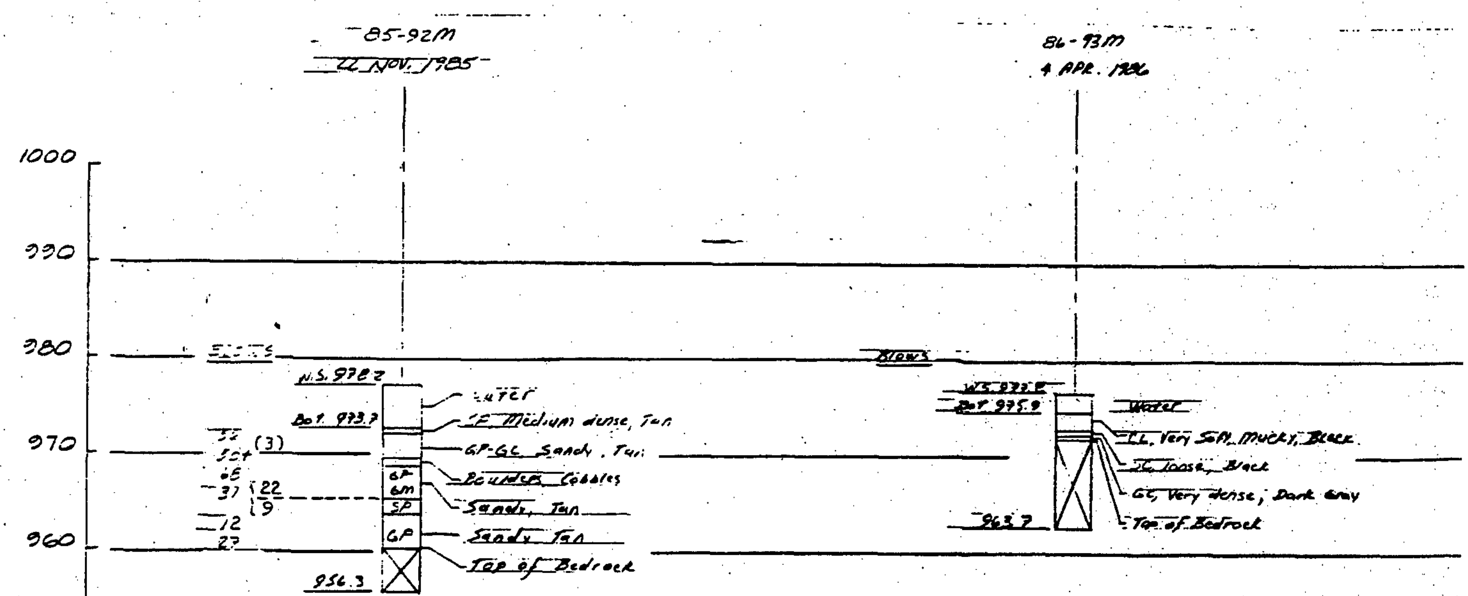
APPROVED BY:
DATE: JANUARY 1987
SCALE: AS SHOWN
DRAWING NUMBER
3
SHEET OF

PLATE B-8



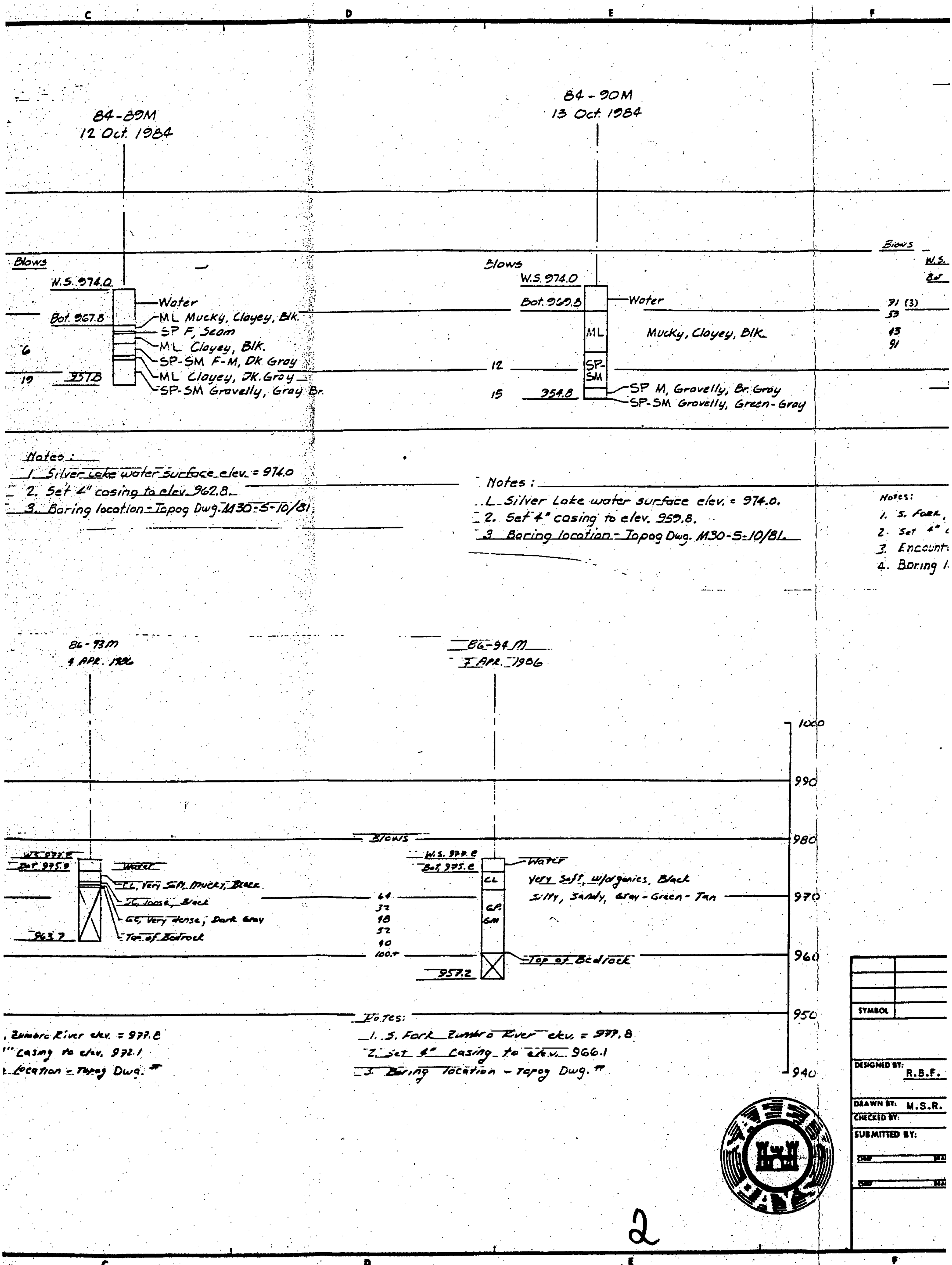
Notes:
1. Silver Lake water surface elev. = 974.0.
2. Set 4" casing to elev. 963.8.
3. Boring location - Topog Dwg. M30-5-10/82.

Notes:
1. Silver Lake water surface elev. = 974.0
2. Set 4" casing to elev. 962.8.
3. Boring location - Topog Dwg. M30-5-10/81.

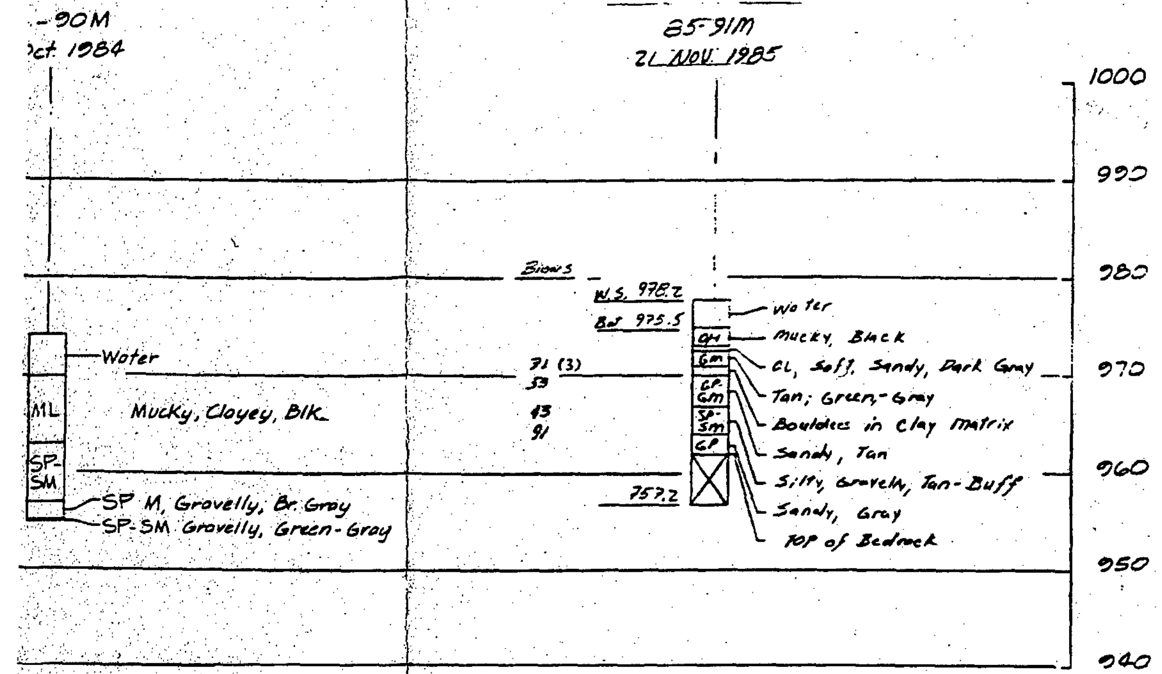


Notes:
1. S. Fork, Zumbro River elev. = 977.8
2. Set 4" Casing to elev. 972.1
3. Boring location - Topog Dwg. *

Notes:
1. S. FORK, Zumbro River elev. = 978.2
2. Set 4" casing to elev. 972.7, 3" casing to elev 960.3
3. Encountered Boulder At elev. 970.0
4. Boring location - Topog Dwg. *



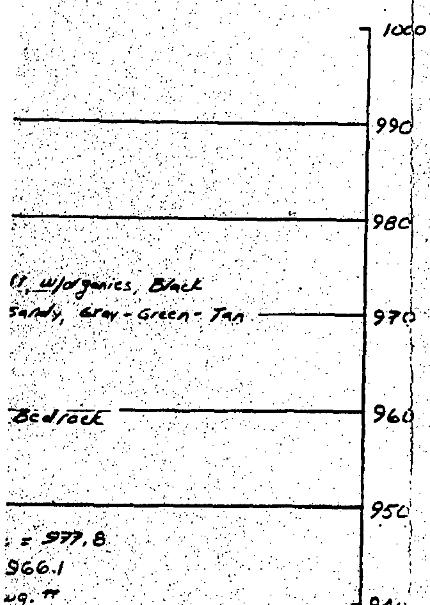
C
D
E
F
84-89M
12 Oct. 1984
84-90M
13 Oct. 1984
Blows
W.S. 974.0
Bot. 967.8
Water
ML Mucky, Clayey, Blk.
SP F, Seam
ML Clayey, Blk.
SP-SM F-M, Dk. Gray
ML Clayey, Dk. Gray
SP-SM Gravelly, Gray Br.
6
19
Blows
W.S. 974.0
Bot. 969.8
Water
ML
Mucky, Clayey, Blk
SP-SM
12
15
954.8
SP M, Gravelly, Br. Gray
SP-SM Gravelly, Green-Gray
Blows
Notes:
1. Silver Lake water surface elev. = 974.0
2. Set 4" casing to elev. 962.8
3. Boring location - Topog Dwg. M30-5-10/81.
Notes:
1. Silver Lake water surface elev. = 974.0.
2. Set 4" casing to elev. 959.8.
3. Boring location - Topog Dwg. M30-5-10/81.
Notes:
3. Encount
4. Boring
86-93M
4 APR. 1986
86-94M
7 APR. 1986
1000
990
980
970
960
950
940
Blows
W.S. 977.8
Bot. 975.8
Water
CL
Very Soft, w/organics, Black
Silty, Sandy, Gray-Green-Tan
GP-GM
64
32
18
52
40
100+
Top of Bedrock
957.2
Water
Top of Bedrock
963.7
Zumbro River elev. = 977.8
Casing to elev. 972.1
Location - Topog Dwg.
Notes:
1. S. Fork Zumbro River elev. = 977.8
2. Set 4" Casing to elev. 966.1
3. Boring location - Topog Dwg.
SYMBOL
DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:
2



water surface elev. = 974.0.
ing to elev. 959.8.
ation - Topog Dwg. M30-5-10/BL

Notes:

1. S. Fork Zumbro River elev = 978.2.
2. Set 4" casing to elev. 972.7
3. Encountered Boulder At elev. 971.7
4. Boring location - Topog Dwg.



SYMBOL	DESCRIPTION	DATE	APPROVAL

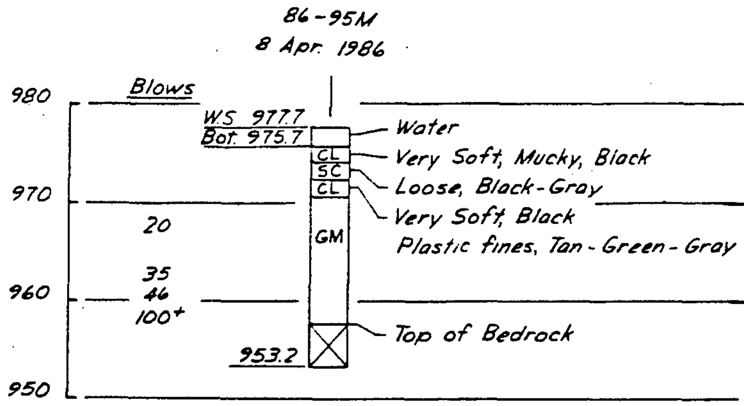
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:

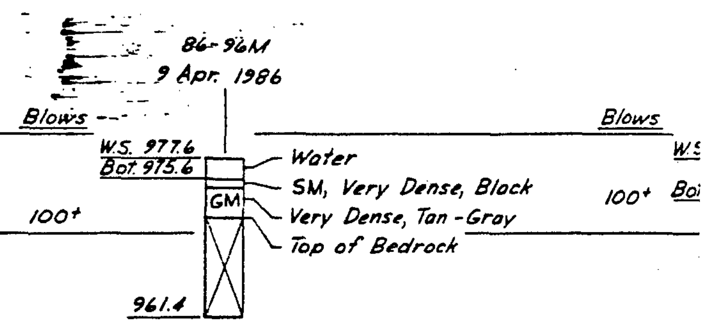
DESIGN MEMORANDUM NO. 2 PHASE IB, FEATURE
APPENDIX - B
FLOOD CONTROL - MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER - ROCHESTER, MINNESOTA
ROCHESTER
BORING LOGS 84-88M THRU 86-94M

APPROVED BY:
DATE: JANUARY 1987
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER
3
SHEET OF

PLATE B-9

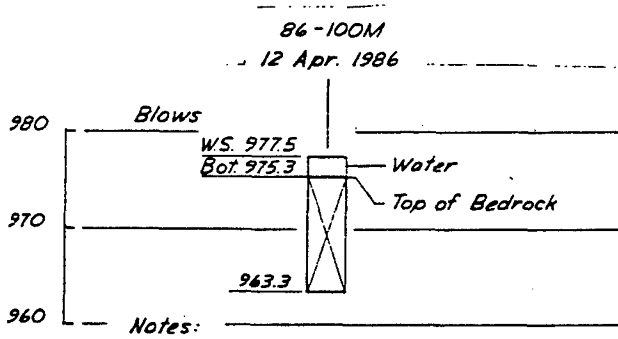


Notes:
1. S. Fork Zumbro River elev. 977.7.
2. Set 4" casing to elev. 970.7.
3. Boring location - Topog. Dwg. #

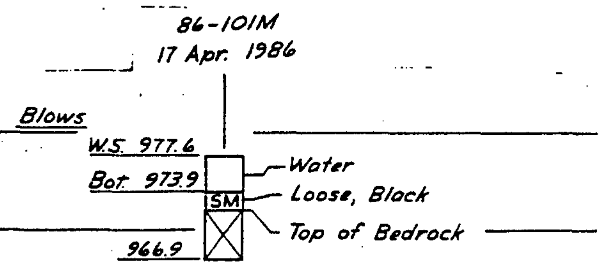


Notes:
1. S. Fork Zumbro River elev. 977.6.
2. Set 4" casing to elev. 973.6.
3. Dolomite Slabs/Boulders on River Bottom.
4. ~~Boring location~~ - Topog. Dwg. #

Notes:
1. S. Fo
2. Set
seale
3. Borin



Notes:
1. S. Fork Zumbro River elev. 977.5.
2. No casing used.
3. 0.7-Ft. Thick by 3-Ft Square Dolomite Slabs Exist On Top Of Bedrock Surfac.
4. Boring location - Topog. Dwg. #



Notes:
1. S. Fork Zumbro River elev. 977.6.
2. Set 4" casing to elev. 971.9.
3. Abundant Scarttered 1 to 3-Ft Diameter Boulders On River Bottom
4. Boring location - Topog. Dwg. #

86-96M
9 Apr. 1986

Blows

W.S. 977.6
Bot. 975.6
100+
961.4

GM

Water
SM, Very Dense, Black
Very Dense, Tan-Gray
Top of Bedrock

ay

Notes:
1. S. Fork Zumbro River elev. 977.6.
2. Set 4" casing to elev. 973.6.
3. Dolomite Slabs/Boulders ON River Bottom.
4. ~~Boring location~~ - Topog. Dwg. #

86-97M
10 Apr. 1986

Blows

W.S. 977.6
100+
Bot. 973.6
967.8

Water
Top of Bedrock

Notes:
1. S. Fork Zumbro River elev. 977.6.
2. Set 4" casing to elev. 972.6, sealed w/grout.
3. Boring location - Topog. Dwg. #

86-98M
10 Apr. 1986

Blows

W.S. 977.6
Bot. 976.1
2
64
48
100+
956.1

CL
GM

Water
Very Soft, Muc
Dense to Very
Cobbles, Gre
SP, Dense, Gr
GM, Dense, Gr
Top of Bedroc

Notes:
1. S. Fork Zumbro River elev. 977.6.
2. Set 4" casing to elev. 967.1.
3. Cobbles And Boulders Encoun
At EL. 972.6
4. Boring location - Topog. Dwg. #

86-101M
17 Apr. 1986

Blows

W.S. 977.6
Bot. 973.9
966.9

SM

Water
Loose, Black
Top of Bedrock

Notes:
1. S. Fork Zumbro River elev. 977.6.
2. Set. 4" casing to elev. 971.9.
3. Abundant Scarttered 1 to 3-Ft Diameter Boulders On River Bottom
4. Boring location - Topog. Dwg. #

86-102M
9 May 1986

Blows

W.S. 974.3
Bot. 972.6
965.6

Water
Top of Bedrock

Notes:
1. S. Fork Zumbro River elev. 974.3.
2. No casing used.
3. Boring location - Topog. Dwg. #

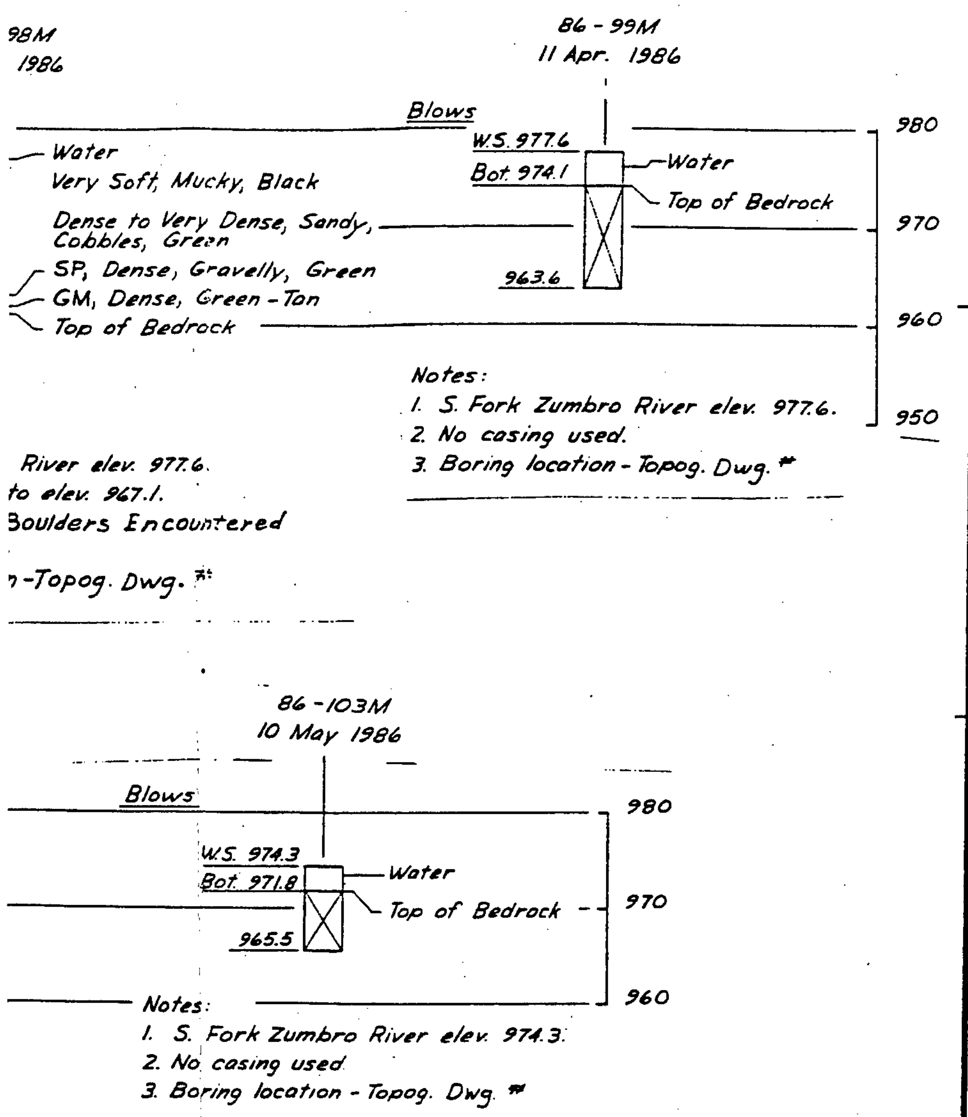
Blows

W
B

Notes:
1. S.
2. No
3. Bor

2

C D E



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:

DESIGN MEMORANDUM NO. 2 PHASE IB, FEATURE
APPENDIX - B
FLOOD CONTROL - MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER - ROCHESTER, MINNESOTA
ROCHESTER
BORING LOGS 86-95M THRU 86-103M

APPROVED BY: DATE:

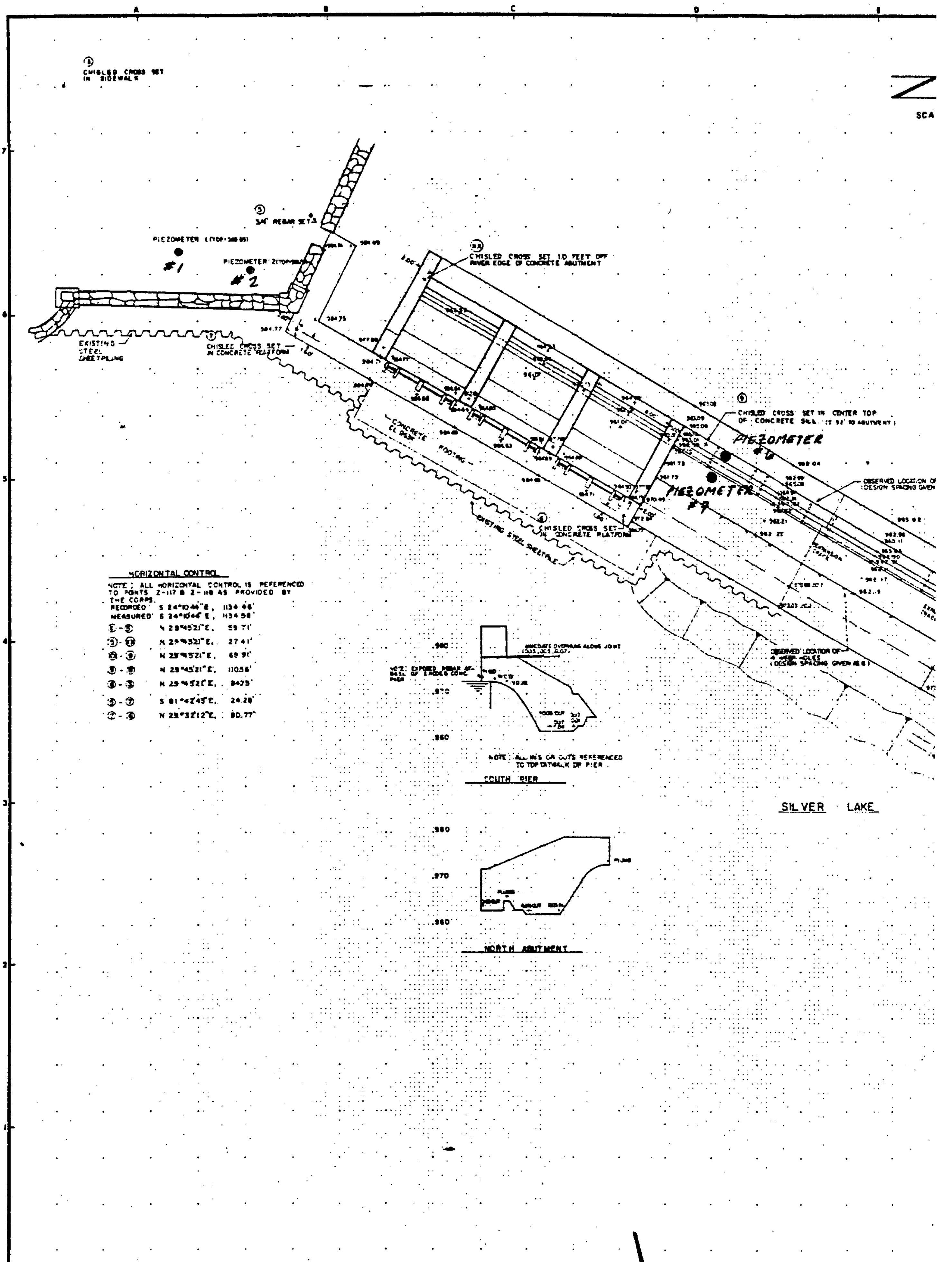
SCALE AS SHOWN SPEC. NO.

DRAWING NUMBER

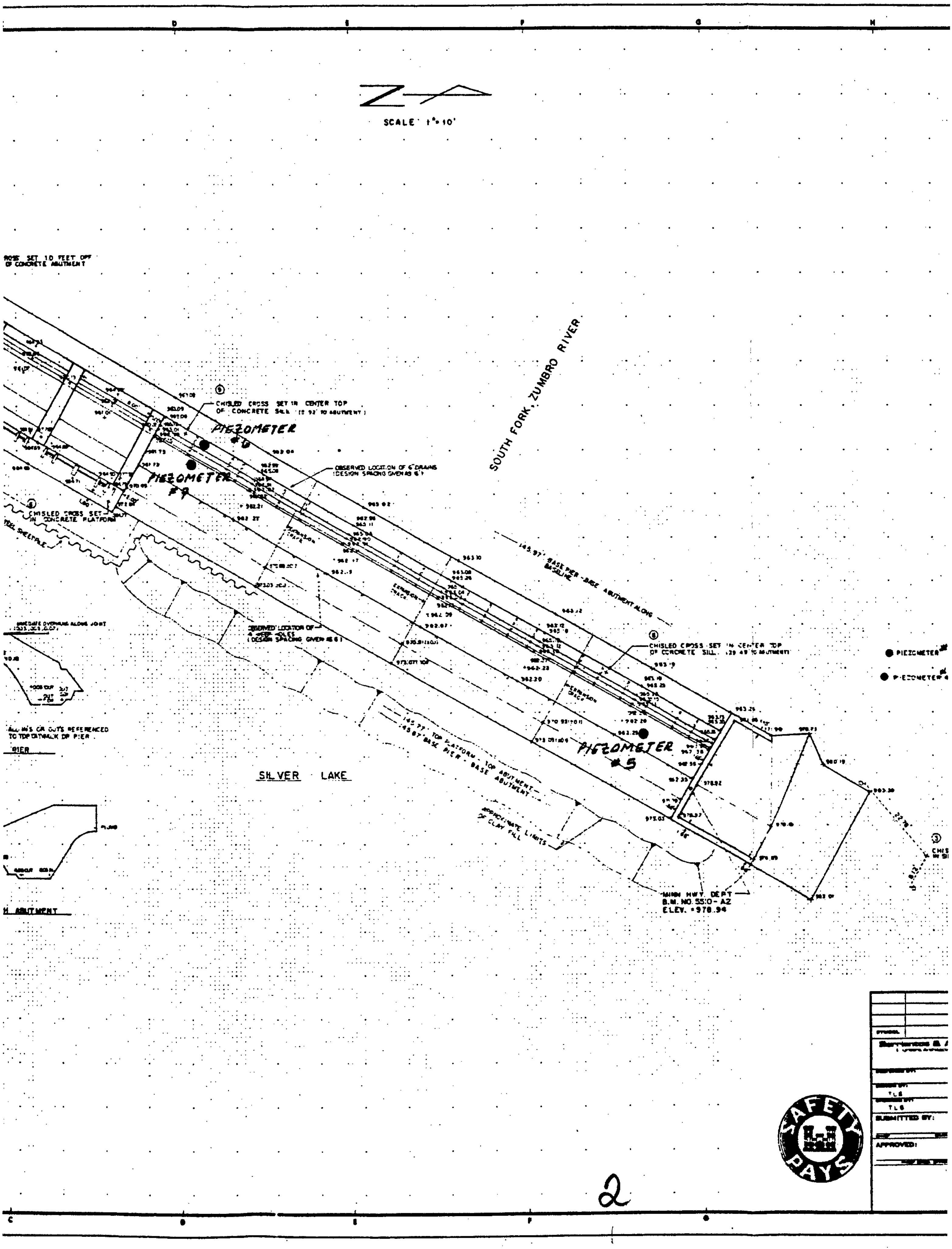
3

SHEET OF

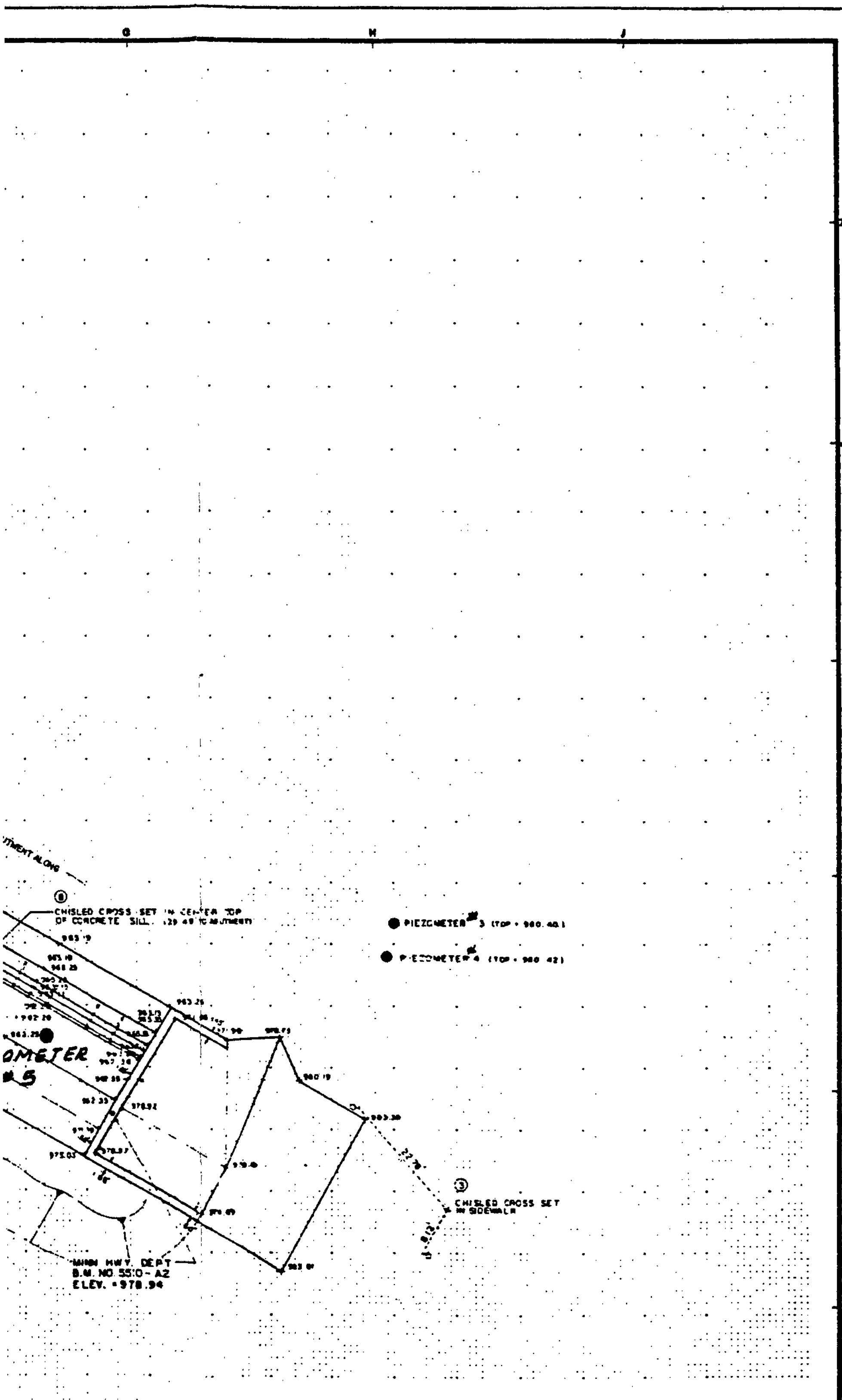
PLATE B-10



CHISLED CROSS SET IN SIDEWALK
3/4" REBAR SET
PIEZOMETER 1
#1
PIEZOMETER 2
#2
EXISTING STEEL SHEETPILING
CHISLED CROSS SET IN CONCRETE PLATFORM
CHISLED CROSS SET 10 FEET OFF RIVER EDGE OF CONCRETE ABUTMENT
CONCRETE FOOTING
CHISLED CROSS SET IN CENTER TOP OF CONCRETE SILL
PIEZOMETER
#8
PIEZOMETER
#9
CHISLED CROSS SET IN CONCRETE PLATFORM
EXISTING STEEL SHEETPILE
OBSERVED LOCATION OF
OBSERVED LOCATION OF WEEP HOLES (DESIGN SPACING GIVEN)
HORIZONTAL CONTROL
NOTE: ALL HORIZONTAL CONTROL IS REFERENCED TO POINTS Z-117 & Z-118 AS PROVIDED BY THE CORPS.
RECORDED S 24°10'44"E, 1134.46'
MEASURED S 24°10'44"E, 1134.56'
N 29°45'21"E, 59.71'
N 29°45'21"E, 27.41'
N 29°45'21"E, 69.91'
N 29°45'21"E, 110.58'
N 29°45'21"E, 84.75'
S 81°42'45"E, 24.20'
N 29°53'12"E, 80.77'
NOTE: EXPOSED REBAR AT BASE OF ERODED CONC. PIER
NOTE: ALL FILLS OR CUTS REFERENCED TO TOP OF WALK OF PIER
SOUTH PIER
NORTH ABUTMENT
SILVER LAKE
SCA



SCALE 1" = 10'
SOUTH FORK, ZUMBRO RIVER
SILVER LAKE
PIEZOMETER #6
PIEZOMETER #9
PIEZOMETER #5
CHISLED CROSS SET IN CENTER TOP OF CONCRETE SILL
OBSERVED LOCATION OF 6" DRAINS (DESIGN SPACING GIVEN AS 6')
CHISLED CROSS SET IN CONCRETE PLATFORM
145.97' BASE PIER - BASE ABUTMENT ALONG BASELINE
145.77' TOP PLATFORM - TOP ABUTMENT
145.87' BASE PIER - BASE ABUTMENT
APPROXIMATE LIMITS OF CLAY FILL
MINN. HWY. DEPT. B.M. NO. 5510-AZ ELEV. = 970.94
ALL ... REFERENCED TO TOP CATWALK OF PIER
PIER
H ABUTMENT
SUBMITTED BY:
APPROVED:
SAFETY PAYS
2



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

TLS

TLS

SUBMITTED BY:

SILVER LAKE DAM

PIEZOMETER LOCATIONS

ROCHESTER, MINNESOTA

APPROVED:

DATE: 7/9/84 - 7/11/84

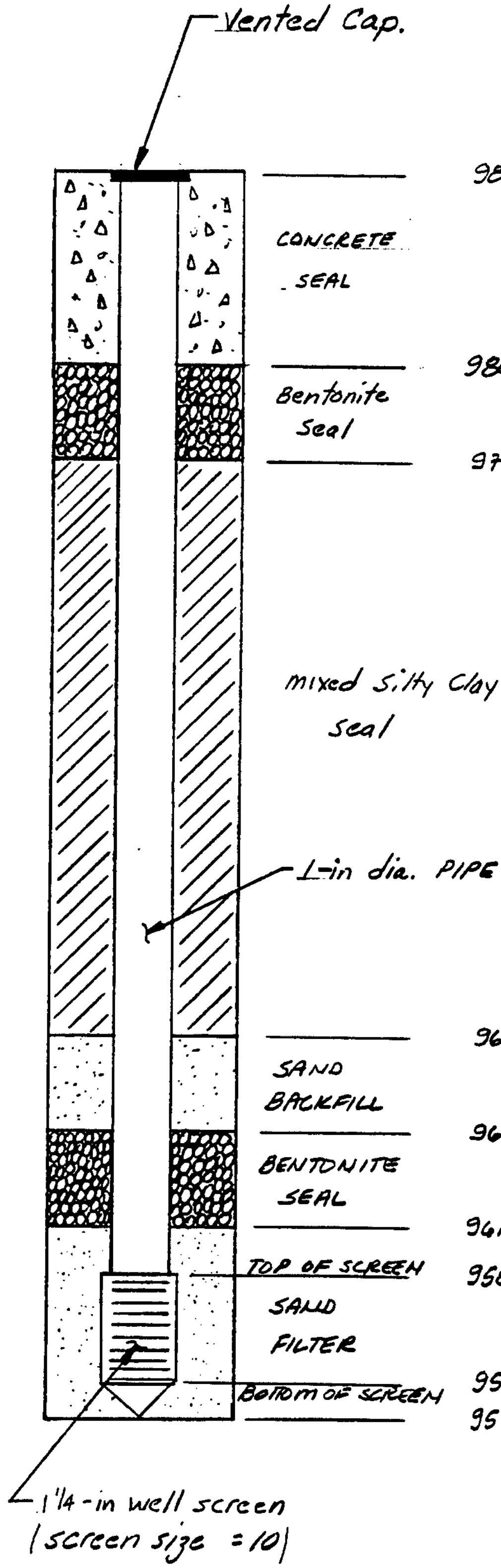
1" = 10'

3

DRAWING NUMBER

PLATE B-11

SHEET OF



PIEZOMETER No.

ELEVATION, FT

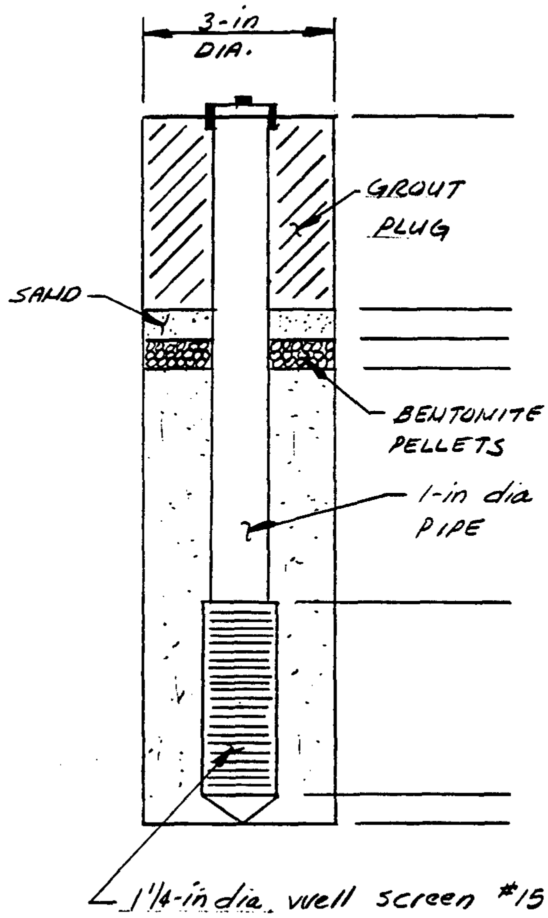
1	2	3	4
983.65	983.80	980.40	980.42
980.65	978.80	975.40	977.92
978.65	976.80	973.40	975.92
969.65	958.80	952.40	965.42
963.65	953.80	947.40	962.92
961.65	951.80	944.40	960.42
958.95	949.50	940.70	958.22
957.45	947.50	938.70	956.22
957.19	946.90	938.40	955.92

DESIGN MEMO. No. FLOOD CONTROL

S. FORK ZUMBRO RIVER
ROCHESTER, MN.
REACH 1B

Silver Lake Dam Piezometers: 1-4
INSTALLATION DETAILS
ST. PAUL DISTRICT

NOVEMBER 1986



PIEZOMETER No.

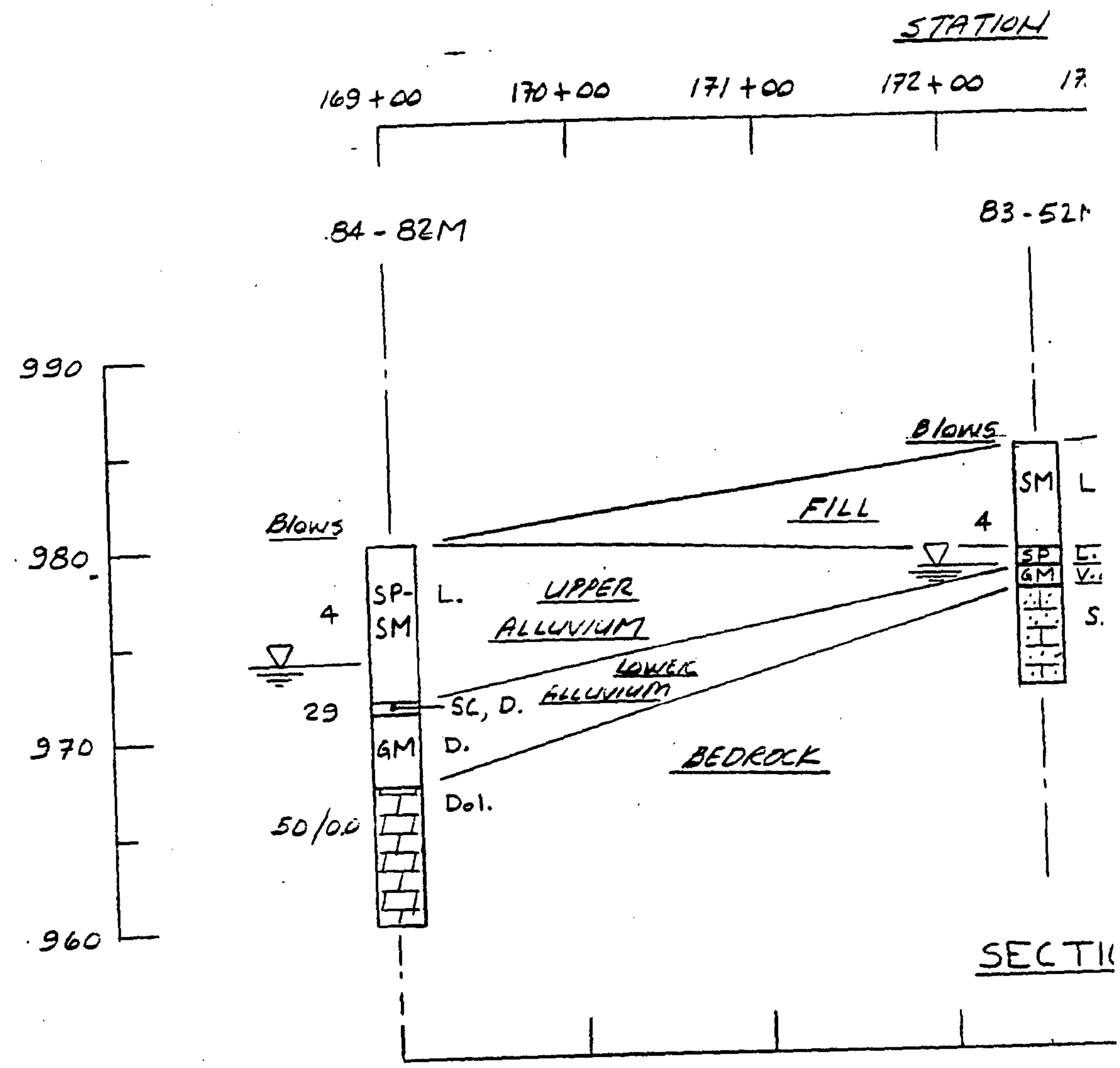
5	6	7
DEPTH BELOW TOP OF CONCRETE, FT.		
0.0	0.0	0.0
0.8	2.1	0.8
0.9	2.3	0.9
1.0	2.5	1.0
2.3	3.4	3.4
3.8	5.4	5.4
4.1	5.6	5.6

DESIGN MEMO. No. FLOOD CONTROL

S. FORK ZUMBRO R.
ROCHESTER, MN.
REACH 1B

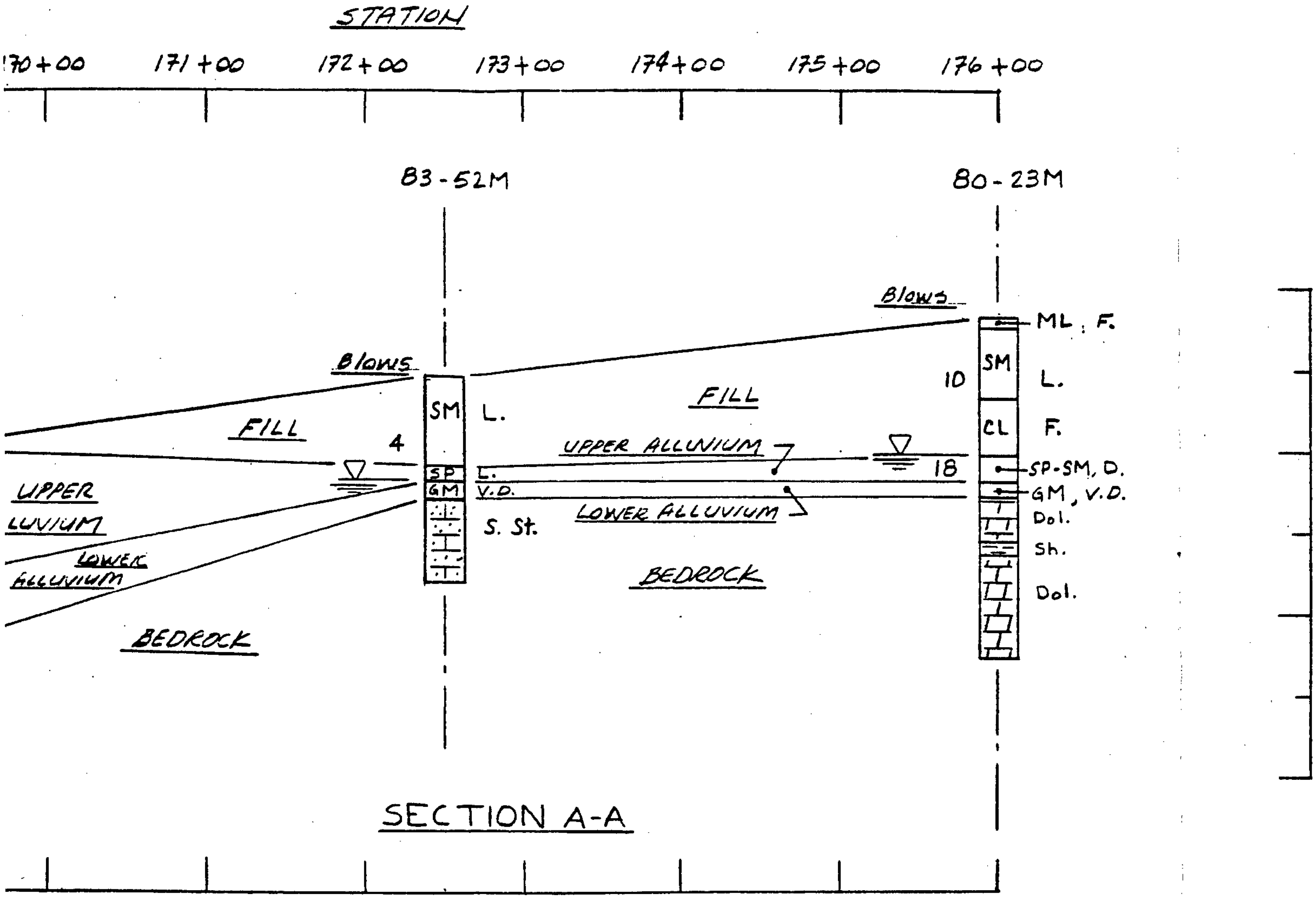
Silver Lake Dam Piezometers: 5-7
INSTALLATION DETAILS
ST. PAUL DISTRICT

November 1986



GENERAL NOTES:

1. "Blows" indicates Standard Penetration Resistance as described on Plate B-
2. Soil types encountered in the borings are given in the stick logs. The consistency of the materials encountered are presented to the right of the
3. A key to the abbreviated descriptions used in the logs is presented on Plate B-15.
4. Descriptions of the methods used to advance the borings, along with other drilling information, are presented on Plates B-4 through B-10.
5. The locations of borings on this plate, with respect to project stationing, approximate. Actual boring locations are shown on Plates 16 through 23.
6. Water levels, indicated by the symbol "∇", represent water levels first encountered in the borings.
7. More detailed descriptions of the subsurface materials encountered are loca on the boring log plates, Plate B-4 through B-10.
8. The type of bedrock encountered in the borings is presented along the right side of the log.
9. The location of Section A-A is shown on Plate B-16 .

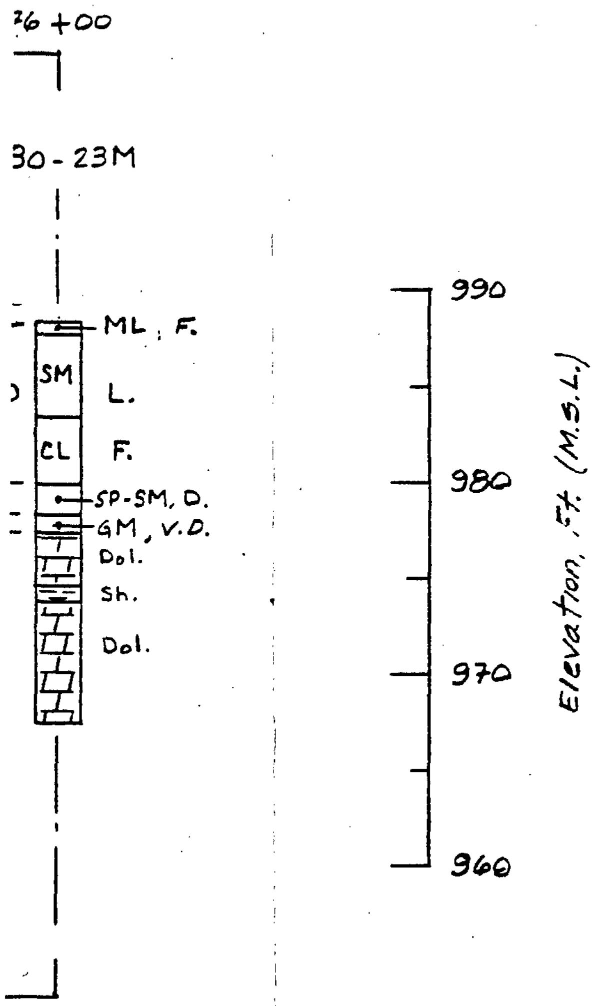


n Resistance as described on Plate B-15.
are given in the stick logs. The
red are presented to the right of the logs
used in the logs is presented on

dvance the borings, along with other
n Plates B-4 through B-10.
e, with respect to project stationing, are
are shown on Plates 16 through 23.
"∇", represent water levels first

surface materials encountered are located
hrough B-10.
e borings is presented along the right

on Plate B-16 .



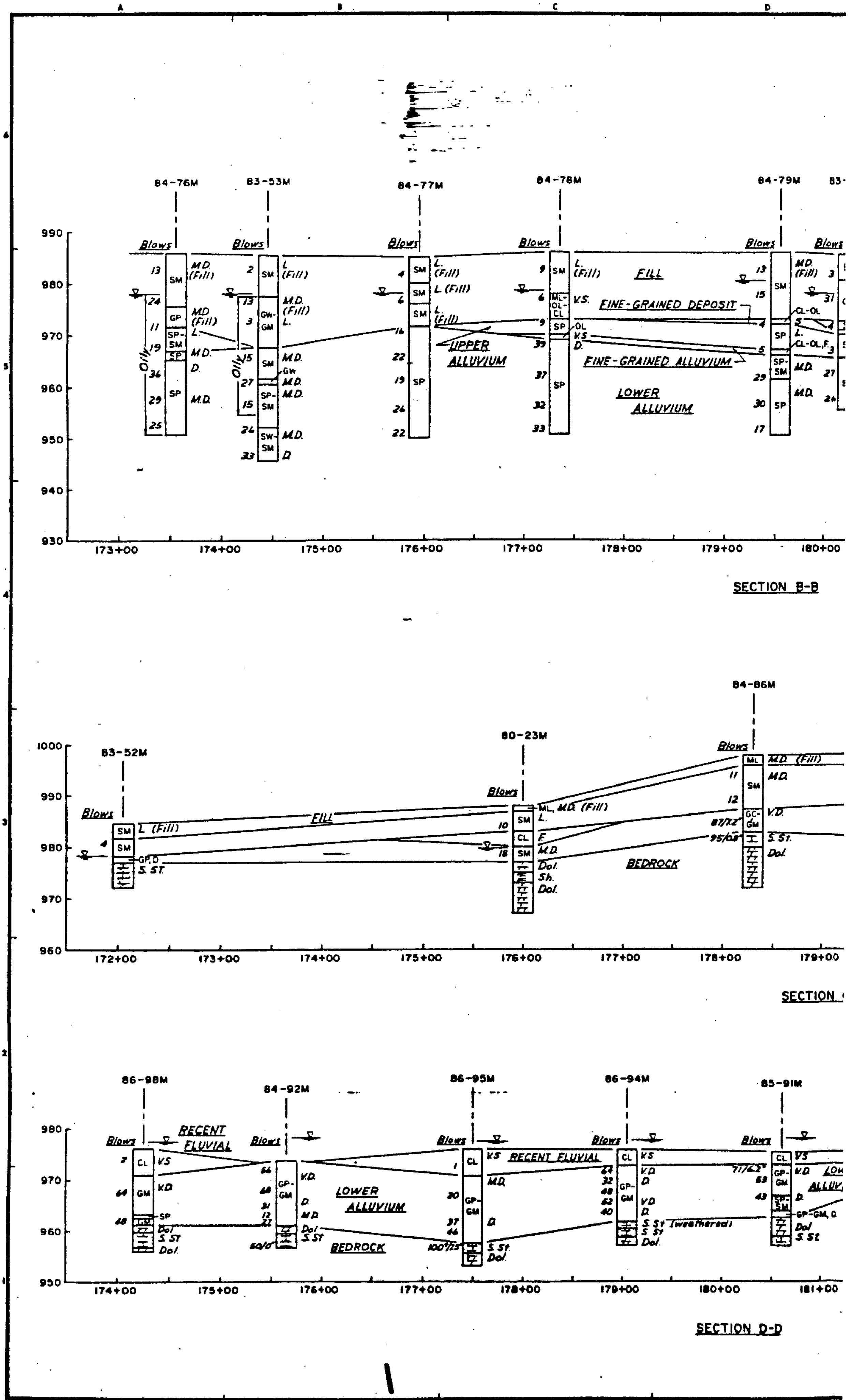
DESIGN MEMORANDUM NO. 2 PHASE IB . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

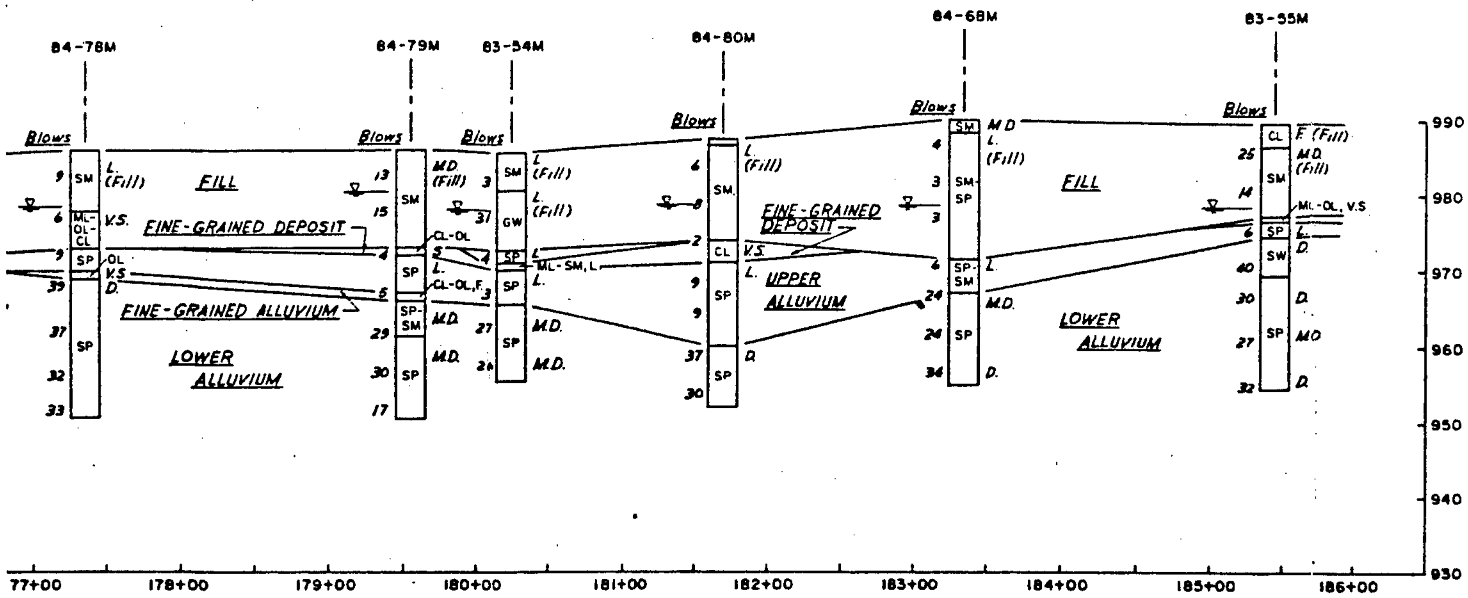
SUBSURFACE PROFILE A-A

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-14

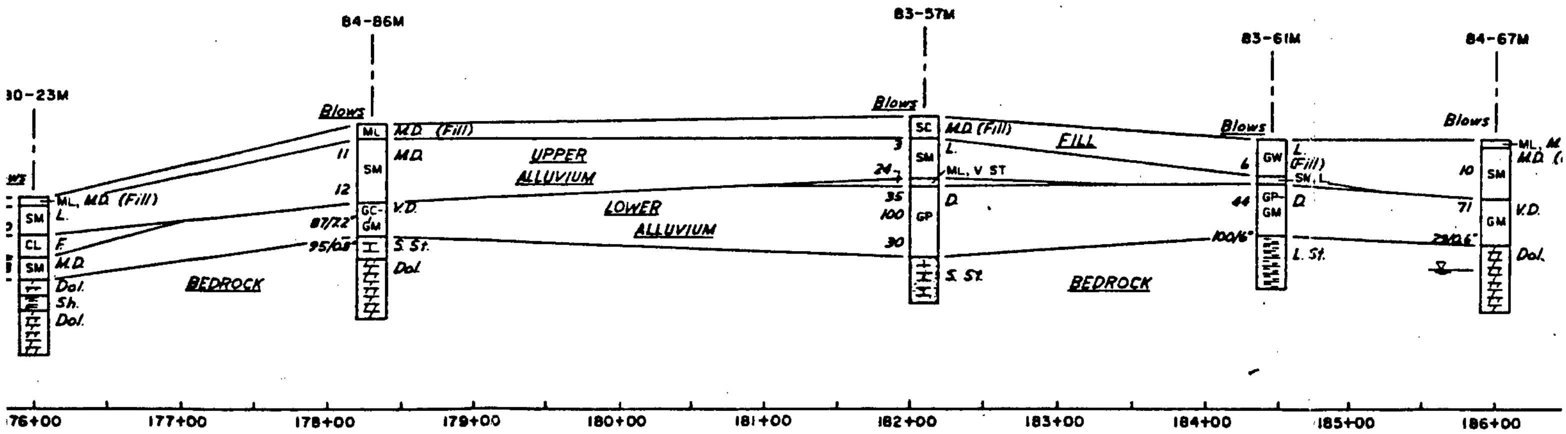
3



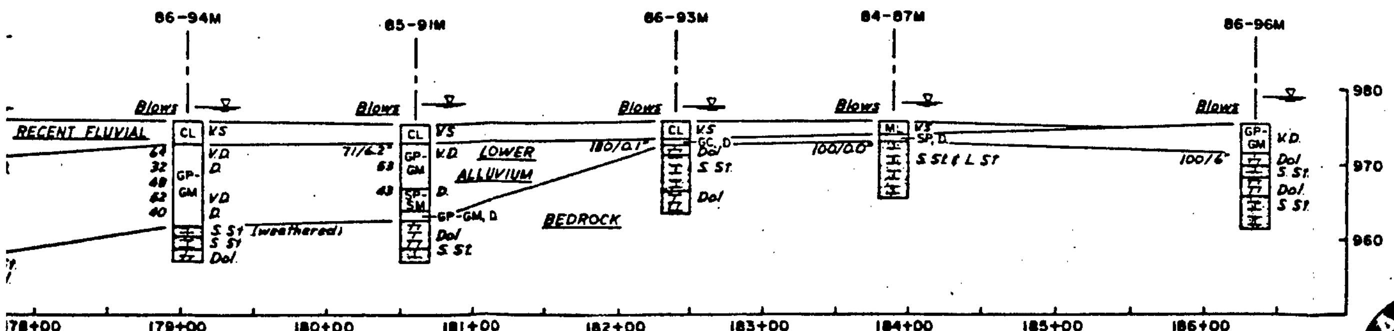
84-76M
83-53M
84-77M
84-78M
84-79M
Blows
FILL
FINE-GRAINED DEPOSIT
UPPER ALLUVIUM
FINE-GRAINED ALLUVIUM
LOWER ALLUVIUM
Oily
173+00
174+00
175+00
176+00
177+00
178+00
179+00
180+00
SECTION B-B
83-52M
80-23M
84-86M
FILL
BEDROCK
172+00
173+00
174+00
175+00
176+00
177+00
178+00
179+00
SECTION
86-98M
84-92M
86-95M
86-94M
85-91M
RECENT FLUVIAL
LOWER ALLUVIUM
BEDROCK
S St (weathered)
174+00
175+00
176+00
177+00
178+00
179+00
180+00
181+00
SECTION D-D



SECTION B-B

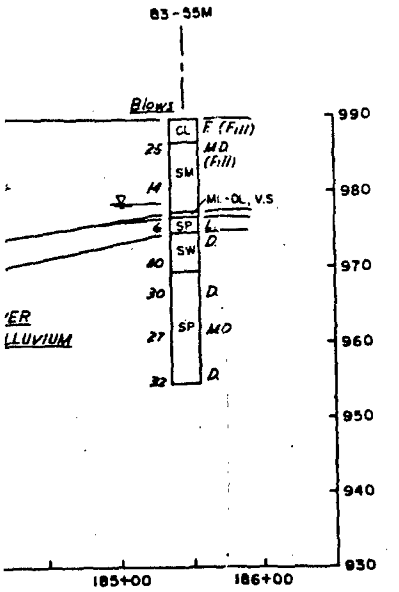


SECTION C-C



SECTION D-D

2



GENERAL NOTES:

1. "BLOWS" INDICATES STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT, UNLESS OTHERWISE NOTED, TO DRIVE A 2-IN. O.D. (STD) SAMPLER WITH A 140-FT LB HAMMER, FALLING 30-IN., AND IS SHOWN TO THE LEFT OF THE BORING LOG.
2. SOIL TYPES ENCOUNTERED IN THE BORINGS ARE GIVEN IN THE STICK LOGS. THE CONSISTENCY OF MATERIAL ENCOUNTERED IS PRESENTED TO THE RIGHT OF THE LOG.
3. A KEY TO ABBREVIATED DESCRIPTIONS USED IN THE LOGS IS PRESENTED ON THIS PLATE.
4. DESCRIPTIONS OF THE METHODS USED TO ADVANCE THE BORINGS, ALONG WITH OTHER DRILLING INFORMATION, ARE PRESENTED ON PLATES B-4 THROUGH B-10.
5. THE LOCATIONS OF BORINGS ON THIS PLATE, WITH RESPECT TO PROJECT STATIONING, ARE APPROXIMATE. ACTUAL BORING LOCATIONS ARE SHOWN ON PLATES 16 THROUGH 23.
6. WATER LEVELS, INDICATED BY THE SYMBOL "∇", REPRESENT WATER LEVELS FIRST ENCOUNTERED IN THE BORINGS.
7. MORE DETAILED DESCRIPTIONS OF SUBSURFACE MATERIALS ENCOUNTERED ARE LOCATED ON THE BORING LOGS, PLATES B-4 THROUGH B-10.
8. IF BEDROCK WAS ENCOUNTERED IN A BORING, THE TYPE OF ROCK IS DESCRIBED ALONG THE RIGHT SIDE OF THE LOG.
9. SECTION LOCATIONS SHOWN ON PLATE B-16.

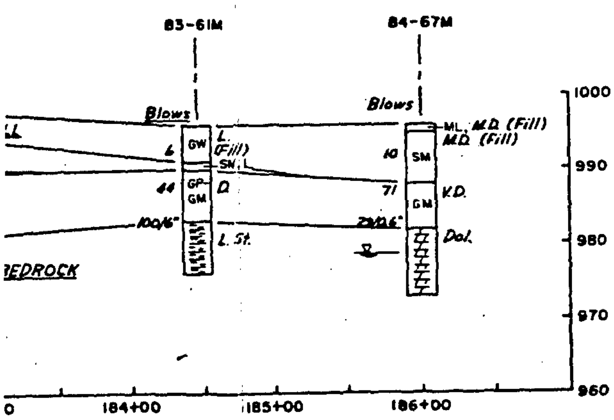
KEY TO ABBREVIATED DESCRIPTIONS

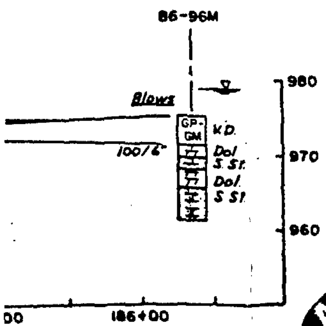
CONSISTENCY

- L. - LOOSE
- M.D. - MEDIUM DENSE
- D. - DENSE
- V.D. - VERY DENSE
- V.S. - VERY SOFT
- S. - SOFT
- F. - FIRM
- ST. - STIFF
- V. ST. - VERY STIFF

SOIL TYPES

- GW - WELL GRADED GRAVELS, LITTLE OR NO FINES.
- GP - POORLY GRADED GRAVELS, LITTLE OR NO FINES.
- GM - SILTY GRAVELS.
- SW - WELL GRADED SANDS, LITTLE OR NO FINES.
- SP - POORLY GRADED SANDS, LITTLE OR NO FINES.
- SM - SILTY SANDS.
- SC - CLAYEY SANDS.
- ML - LOW PLASTICITY SILTS, LIQUID LIMIT LESS THAN 50.
- MH - HIGHLY PLASTIC SILTS, LIQUID LIMIT GREATER THAN 50.
- CL - LOW PLASTICITY CLAYS, LIQUID LIMIT LESS THAN 50.
- CH - HIGHLY PLASTIC CLAYS, LIQUID LIMIT GREATER THAN 50.
- OL - ORGANIC SILTS/CLAYS, LIQUID LIMIT LESS THAN 50.
- OH - ORGANIC SILTS/CLAYS, LIQUID LIMIT GREATER THAN 50.
- DOL. - DOLOMITE
- S. ST. - SANDSTONE
- SH. - SHALE
- L. ST. - LIMESTONE





SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

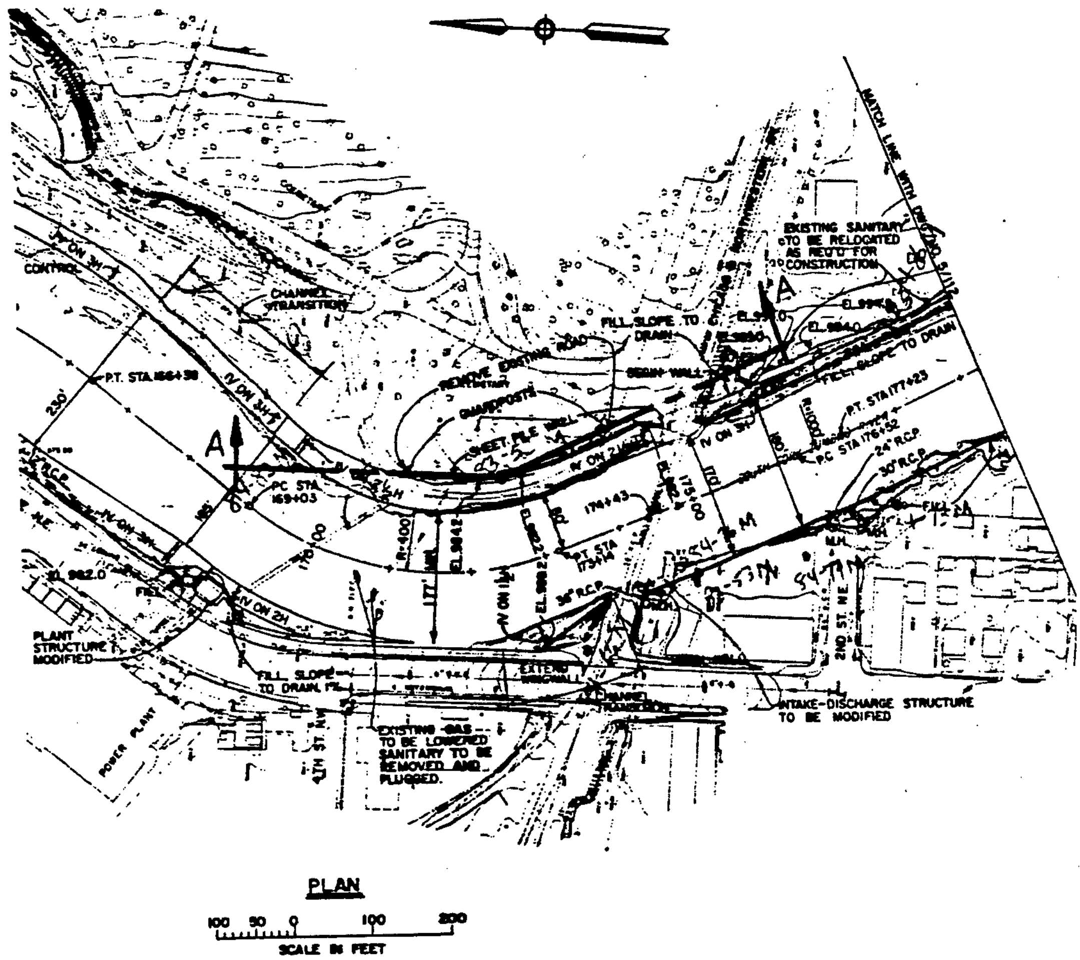
DESIGNED BY: RBF
DRAWN BY: MSR
CHECKED BY:
SUBMITTED BY:

DESIGN MEMORANDUM NO. PHASE , FEATURE
APPENDIX-B
FLOOD CONTROL - MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER - ROCHESTER, MINNESOTA
ROCHESTER
SUBSURFACE SECTIONS B-B, C-C & D-D

APPROVED BY:
DATE: JANUARY 1987
SCALE: AS SHOWN
DRAWING NUMBER
SHEET OF

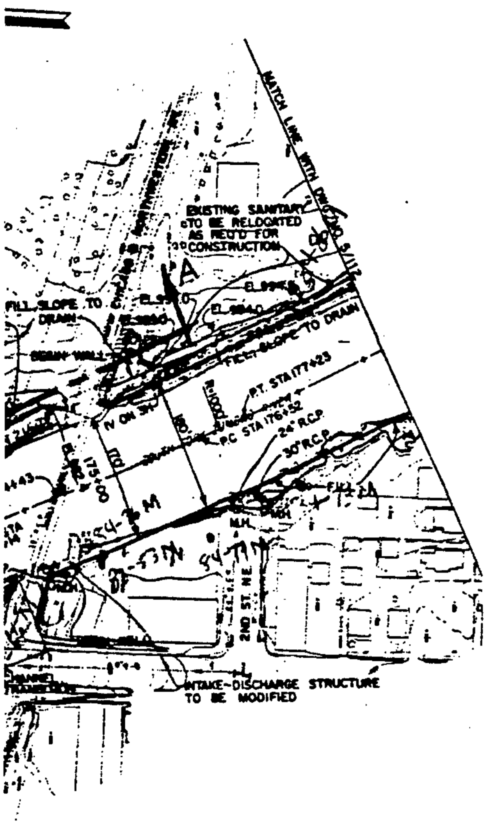
3

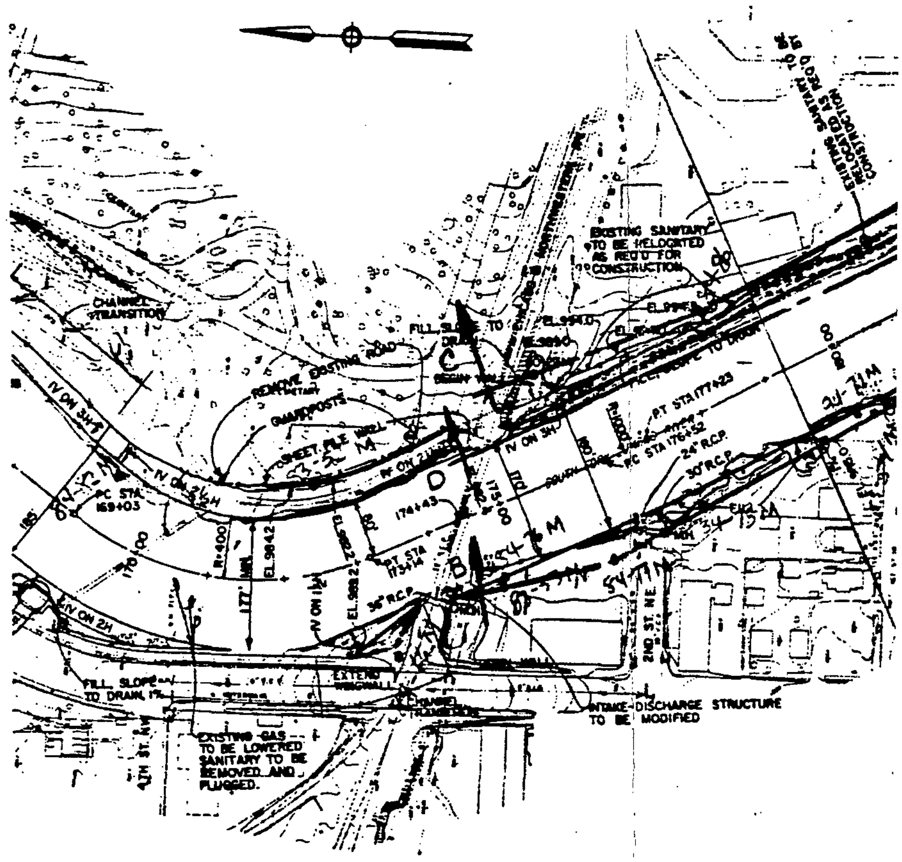
PLATE B-15



CONTROL
CHANNEL TRANSITION
P.T. STA 166+38
PC STA 169+03
FILL SLOPE TO DRAIN
REMOVE EXISTING ROAD
GUARDPOSTS
SHEET PILE WALL
PLANT STRUCTURE MODIFIED
FILL SLOPE TO DRAIN
EXTEND WINGWALL
EXISTING GAS TO BE LOWERED SANITARY TO BE REMOVED AND PLUGGED.
POWER PLANT
EXISTING SANITARY TO BE RELOCATED AS REQ'D FOR CONSTRUCTION
MATCH LINE
P.T. STA 177+23
P.C STA 176+52
24" R.C.P.
30" R.C.P.
36" R.C.P.
INTAKE-DISCHARGE STRUCTURE TO BE MODIFIED
2ND ST. NE
PLAN
100 50 0 100 200
SCALE IN FEET

SECTION A-A





PLAN

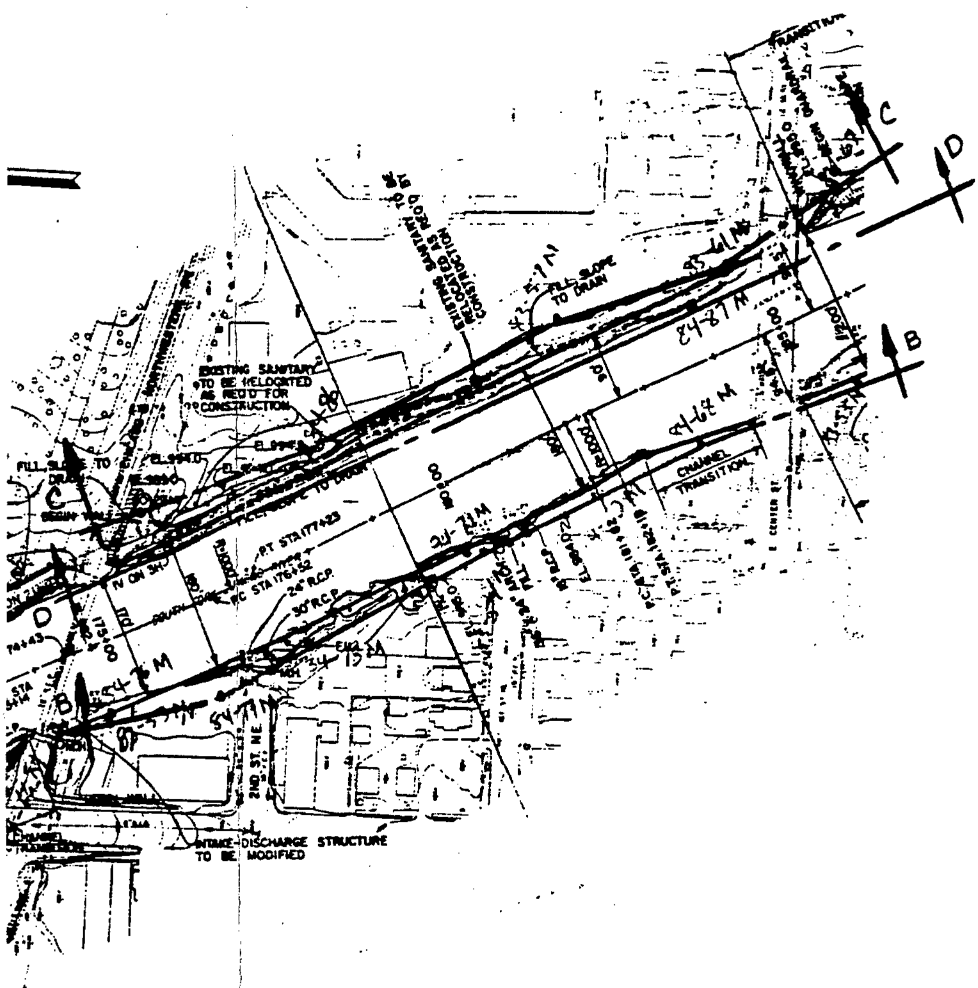
100 50 0 100 200
SCALE IN FEET

SECTIONS B-B, C-C, & D-D

DE

St.
Fi

2



ECTIONS B-B, C-C, & D-D

DESIGN MEMORANDUM NO. 2 PHASE 1B , - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

SUBSURFACE PROFILE LOCATIONS

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-16

3

SOIL C

Project: ROCHESTER FLOOD CONTROL: REACH 1B FDM

Station:

Range:

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Pe — Hyd. Analsis — Fines .005	.02mm	200	U. S. Standard — Sand 80	40	20	10
Hole	80-13										
2	6.6						21	36	74	83	87
4	19.6	18.6	32	16							
8	31.5						6	14	49	80	93
Hole	80-14										
2	6.4						17	29	64	80	87
3	12.1	32.3	49	20							
6	19.4						8	12	29	57	76
Hole	80-20										
3	5.7										
7	14.4						3	7	63	92	98
10	26.4						9	17	42	76	93
Hole	80-21										
4	11.6	55.0	72	39							
5	14.2						4	7	75	98	100
7	24.3						5	10	38	65	82
Hole	80-22										
5	6.3	23.0	36	13							
7	11.6						5	6	9	15	20
9	19.3						7	14	42	70	87
Hole	80-23										
2	1.6										
3	9.4										
Hole	81-32										
3	10.8						2	4	49	93	98
4	16.3						3	6	31	62	81

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

ROL: REACH 1B FDM

Boring No: 80-13M thru 81-3

Range:

Surf. Elev:

Depth To Water Table:

s)	Grading (Cumulative Percents Finer)												Gradation Curve Analysis					Classifi
	Hyd. Analisis		U. S. Standard Sieve Sizes															
	Fines			Sand					Gravel									
.	.005	.02mm	200	80	40	20	10	4	3/8	3/4	1 1/2	3 in	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Tech. MEMO 3-
			21	36	74	83	87	91	93	95	100							
													0.50	0.30	0.15	3.3	1.2	CL
			6	14	49	80	93	98	100									
			17	29	64	80	87	94	97	100								
																		ML
			8	12	29	57	76	91	99.	100			0.95	0.42	0.13	7.3	1.4	
																		CL
			3	7	63	92	98	99	100				0.40	0.27	0.18	2.2	1.0	
			9	17	42	76	93	98	100				0.58	0.28	0.090	6.4	1.5	
																		MH
			4	7	75	98	100						0.38	0.27	0.18	2.1	1.1	
			5	10	38	65	82	95	99	100			0.78	0.36	0.16	4.9	1.0	
																		CL
			5	6	9	15	20	27	33	42	54	100	44.0	7.0	0.42	104.6	2.7	
			7	14	42	70	87	94	98	100			0.62	0.30	0.12	5.2	1.2	
			2	4	49	93	98	100					0.46	0.30	0.20	2.3	0.98	
			3	6	31	62	81	88	96	100			0.80	0.40	0.19	4.2	1.1	

BSOLETE

2

RD SHEET

-	Boring No: 80-13M thru 81-32M	MRD Lab. No:
	Depth To Water Table:	Bottom Of Hole:

ation Curve Analysis				Classification	Remarks
30 (mm)	D_{10} (mm)	C_u	C_c	*Tech. MEMO 3-357, May 67*	PL
.30	0.15	3.3	1.2	CL	16
				ML	29
42	0.13	7.3	1.4		
				CL	
27	0.18	2.2	1.0		
28	0.090	6.4	1.5		
				MH	33
27	0.18	2.1	1.1		
36	0.16	4.9	1.0		
				CL	23
0	0.42	104.6	2.7		
30	0.12	5.2	1.2		
30	0.20	2.3	0.98		
40	0.19	4.2	1.1		

DESIGN MEMORANDUM NO. PHASE . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CLASSIFICATION TEST RESULTS
80-13M THRU 81-32M

3

St. Paul District. U.S. Army Corps of Engineers
File No. January 1987
PLATE B-17

SOIL C

Project: ROCHESTER FLOOD CONTROL: REACH 1B FDM

Station:

Range:

Sample No.	Depth To Bottom Of Sample	Moist-ure (%)	Plasticity (Att. Limits)		Grading (Cumulative P						
					Hyd. Analsis		U. S. Standard				
					Fines			Sand			
			L.L.	P.I.	.005	.02mm	200	80	40	20	10
Hole	81-44										
2	5.9						2	2	24	71	83
3	9.2						10	48	97	99	100
4	14.0						5	19	54	77	89
6	24.0						4	9	35	59	79
8	33.9						8	14	39	61	80
11	44.3						4	6	32	59	84
14	56.4						13	18	24	31	40
Hole	83-52M										
1	3.0						15	26	84	98	100
Hole	83-54M										
3	11.5	17.1	26	15			43	52	76	87	92
4	13.5		-				3	6	48	84	97
6	20.5						4	6	39	70	82
Hole	83-55M										
2	6.5						21	24	34	43	54
3	10.5						25	28	38	48	61
4	16.5						2	4	17	35	61
5	21.5						4	7	32	64	86
Hole	83-56M										
1	1.5						44	53	61	75	80
2	6.5						4	9	56	83	91
3	11.5						6	9	20	29	38
Hole	83-57M										
2	6.5						25	29	65	92	98
5	16.5						12	14	18	20	26

SOIL CLASSIFICATION RECORD SHEET

OL: REACH 1B FDM

Boring No: 81-44M through 83-57M

Range:

Surf. Elev:

Depth To Water Table:

/ s) l.	Grading (Cumulative Percents Finer)												Gradation Curve Analysis					Classif
	Hyd. Analsis		U. S. Standard Sieve Sizes															
	Fines			Sand					Gravel									
	.005	.02mm	200	80	40	20	10	4	3/8	3/4	1 1/2	3 in	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Tech. MEMO 3
			2	2	24	71	83	86	89	97	100		0.68	0.45	0.28	2.4	1.1	
			10	48	97	99	100						0.22	0.11	0.074	3.0	0.74	
			5	19	54	77	89	94	100				0.47	0.24	0.11	4.3	1.1	
			4	9	35	59	79	90	97	97	100		0.87	0.36	0.18	4.8	0.83	
			8	14	39	61	80	91	100				0.80	0.30	0.11	7.3	1.0	
			4	6	32	59	84	91	94	96	100		0.89	0.40	0.19	4.7	0.95	
			13	18	24	31	40	52	70	87	100							
			15	26	84	98	100											
			43	52	76	87	92	95	100									CL
			3	6	48	84	97	100					0.50	0.29	0.18	2.8	0.93	
			4	6	39	70	82	89	93	97	100		0.60	0.33	0.19	3.2	0.99	
			21	24	34	43	54	69	80	92	100							
			25	28	38	48	61	72	82	98	100							
			2	4	17	35	61	90	96	97	100		1.9	0.69	0.29	6.6	0.86	
			4	7	32	64	86	94	97	98	100		0.78	0.39	0.19	4.1	1.0	
			44	53	61	75	80	84	87	91	100							
			4	9	56	83	91	94	97	100			0.43	0.27	0.18	2.4	0.94	
			6	9	20	29	38	52	66	81	100		6.7	0.91	0.13	51.5	0.95	
			25	29	65	92	98	100										
			12	14	18	20	26	38	46	87	100		11.9	2.4	0.059	201.7	8.2	

OBSOLETE

2

ORD SHEET

Boring No: 81-44M through 83-57M	MRD Lab. No:
Depth To Water Table:	Bottom Of Hole:

adation Curve Analysis				Classification	Remarks
D_{30} (mm)	D_{10} (mm)	C_u	C_c	Tech. MEMO 3-357, May 67	PL
0.45	0.28	2.4	1.1		
0.11	0.074	3.0	0.74		
0.24	0.11	4.3	1.1		
0.36	0.18	4.8	0.83		
0.30	0.11	7.3	1.0		
0.40	0.19	4.7	0.95		
				CL	11
0.29	0.18	2.8	0.93		
0.33	0.19	3.2	0.99		
0.69	0.29	6.6	0.86		
0.39	0.19	4.1	1.0		
0.27	0.18	2.4	0.94		
0.91	0.13	51.5	0.95		
2.4	0.059	201.7	8.2		

DESIGN MEMORANDUM NO. PHASE , - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CLASSIFICATION TEST RESULTS
81-44M THRU 83-57M

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-18

3

SOIL C

Project:

ROCHESTER FLOOD CONTROL: REACH 1B, FDM

Station:

Range:

Sample No.	Depth To Bottom Of Sample	Moist-ure (%)	Plasticity (Att. Limits) L.L.	P.I.	Grading (Cumulative P — Hyd. Analsis — Fines .005	.02mm	200	U. S. Standard — Sand 80	40	20	10
Hole	82-61M										
2	6.5						10	18	31	36	40
3	11.5						21	28	40	45	50
					Grading (Cumulative P						
Testing by Soil					Hyd. Analsis			U. S. Standard			
Exploration Co. St			Paul	MN	Fines			Sand			
					.005	.02mm	200	100	40	20	10
Hole	84-65M										
2	4.0-4.5						21	27	71		93
3	5.5-6.5	14.6	22	7			36	40	70		93
4	8-9						8	10	55		90
Hole	84-66M										
1	1-2						21	26	55		77
2	5.5-6.5	16.5	30	15							
4	13.5-14	5					5	10	94		100
6	16.9-18	21.8	26	13							
Hole	84-67M										
1	3-4	4.8	14	1			19	23	70		95
2	5.5-6.2						21	29	42		51
Hole	84-68M										
4	13.5-15	0					11	19	49		93
Hole	84-74M										
2	1-1.9						11	15	49		68
3	1.9-2.3						7	11	82		99
5	6.5-7.5						2	3	66		98
7	10-10.7						1	1	6		24
8	15-17						2	4	25		83
9	18-19						5	7	40		85

MRD FORM 16 NOV. 75 EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

H 1B FDM		Boring No: 82-61M through 84-74M
Range:	Surf. Elev:	Depth To Water Table:

Grading (Cumulative Percents Finer)												Gradation Curve Analysis					Classificati
Hyd. Analsis		U. S. Standard Sieve Sizes															
Fines			Sand					Gravel									
005	.02mm	200	80	40	20	10	4	3/8	3/4	1 1/2	3 in	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	*Tech. MEMO 3-357*
		10	18	31	36	40	46	51	58	86	100	19.9	0.38	0.056	355.4	0.13	
		21	28	40	45	50	59	66	75	100							

Grading (Cumulative Percents Finer)																	
Hyd. Analsis		U. S. Standard Sieve Sizes															
Fines			Sand					Gravel									
005	.02mm	200	100	40	20	10	4	3/8	3/4	1	1.5"						
		21	27	71		93	96	99	100								
		~~36~~	~~40~~	~~70~~		~~93~~	~~97~~	~~98~~	~~100~~								SC-SM
		8	10	55		90	95	100									
		21	26	55		77	87	93	100								
																	CL
		5	10	94		100											
																	CL
		19	23	70		95	100										SM
		21	29	42		51	59	70	87	90	100						
		11	19	49		93	99	100									
		11	15	49		68	71	74	79	88	100						
		7	11	82		99	100										
		2	3	66		98	99	100									
		1	1	6		24	29	34	57	61	100						
		2	4	25		83	94	99	100								
		5	7	40		85	93	96	100								

.ETE

DESIGN

St. Pau
File No

2

) SHEET

Boring No: 82-61M through 84-74M	MRD Lab.No:
Depth To Water Table:	Bottom Of Hole:

n Curve Analysis			Classification	Remarks
D_{10} (mm)	C_u	C_c	Tech. MEMO 3-357, May 67	PL
0.056	355.4	0.13		
			SC-SM	15
			CL	15
			CL	13
			SM	13

DESIGN MEMORANDUM NO. 2 PHASE /B . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CLASSIFICATION TEST RESULTS
83-61M THRU 84-74M

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-19

SOIL CL

Project: ROCHESTER FLOOD CONTROL: REACH 1B FDM

Station: | Range:

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Per — Hyd. Analsis — Fines .005	.02mm	U. S. Standard — 200	Sand 100	40	20	10	
Hole	84-75M											
2	3.4-4.4	21.5	39	18								
3	5-6						17	23	45		62	6
4	10.2-11.2	11.5	15	0								
6	13-14						7	10	27		58	7
7	16-17						3	5	34		76	8
Hole	84-77M											
2	1.5-2.5						21	26	51		68	7
3	9-10						12	17	95		100	
4	13.5-14	44.3	34	14								
Hole	84-80M											
3	10-11						15	19	45		78	9
6	16.5-17.3						2	5	54		98	1
Hole	84-82M											
1	3-4						2	3	38		95	1
2	6.3-6.7						1	3	55		97	
Hole	84-88M											
1	7-7.3	67.5	42	22			69	71	85		91	
5	15-16						6	7	55		81	

MRD FORM
NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

EACH 1B FDM

Boring No: 84-75M through 84-88M

MRD

nge:

Surf. Elev:

Depth To Water Table:

Bott

Isis	Grading (Cumulative Percents Finer) U.S. Standard Sieve Sizes									Gradation Curve Analysis					Classification
s	Sand					Gravel									
m 200	100	40	20	10	4	3/8	3/4	1	3 in	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Tech. MEMO 3-357, May
17	23	45		62	68	75	98	100							CL
7	10	27		58	72	86	100								SM
3	5	34		76	84	90	97	100							
21	26	51		68	77	87	97	100							
12	17	95		100											
															CL
15	19	45		78	90	96	100								
2	5	54		98	100										
2	3	38		95	100										
1	3	55		97	99	100									
69	71	85		91	93	100									CL
6	7	55		81	82	100									

DESIGN MEMORA

CLA

St. Paul Dist
File No.

2

...RD SHEET

Boring No: 84-75M through 84-88M	MRD Lab. No:
Depth To Water Table:	Bottom Of Hole:

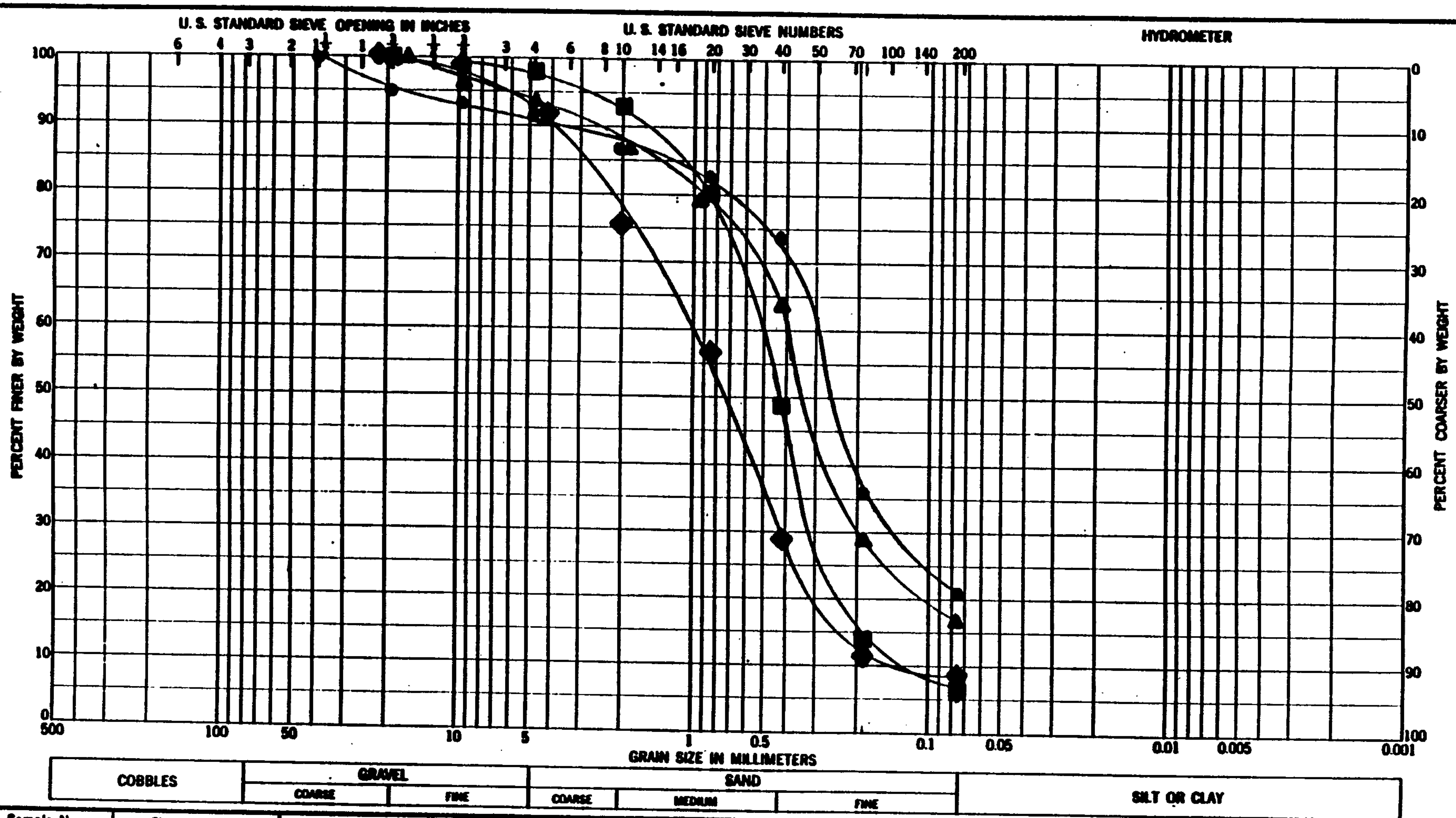
...tion Curve Analysis				Classification	Remarks
...0 (...m)	D_{10} (mm)	C_u	C_c	*Tech. MEMO 3-357, May 67*	PL
				CL	19
				SM	15
				Cl	20
				CL	20

DESIGN MEMORANDUM NO. 2 PHASE IB . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CLASSIFICATION TEST RESULTS
84-75M THRU 84-88M

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-20



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
80-13M(1) ●	6.6	SILTY SAND W/GRAVEL (SM) ~ (FILL)				
80-13M(8) ■	31.5	SAND (SW) ~ (Lower Alluvium)				
80-14M(2) ▲	6.4	SILTY SAND W/TRACE GR (SM) ~ (FILL)				
80-14M(6) ◆	19.4	SAND (SW) ~ (Lower Alluvium)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

Boring No. 80-13M & 80-14M

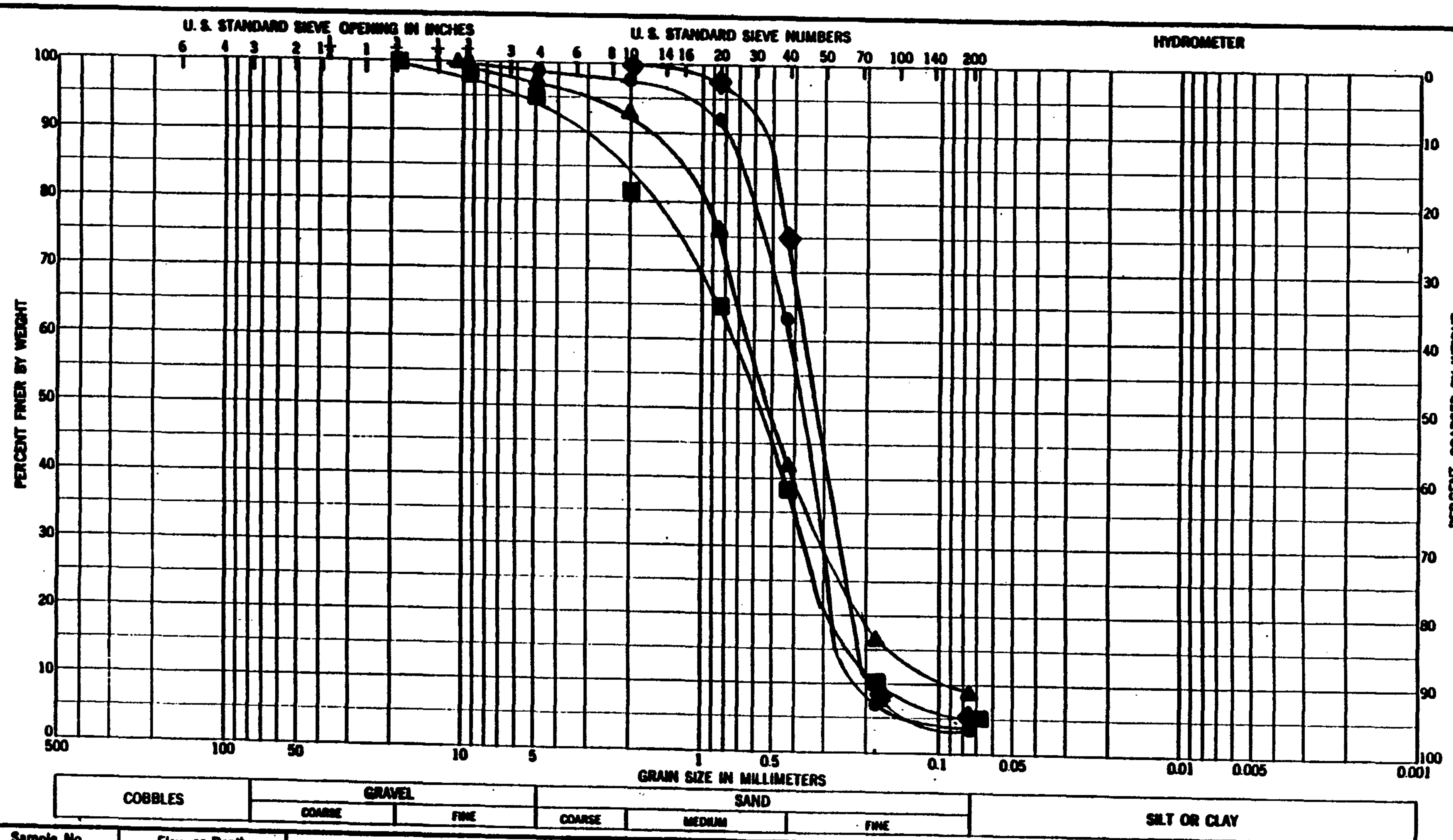
Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-21

21



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
80-20M(7) ●	14.4	SAND (SP) ~ (UPPER Alluvium)				
80-20M(10) ▲	26.4	SAND (SP) ~ (Lower Alluvium)				
80-21M(5) ◆	14.2	FINE SAND (SP) ~ UPPER ALLUV.				
80-21M(7) ■	21.3	SAND W/GRAVEL (SW) ~ (Low. All.)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

Boring No. 80-20M & 80-21M

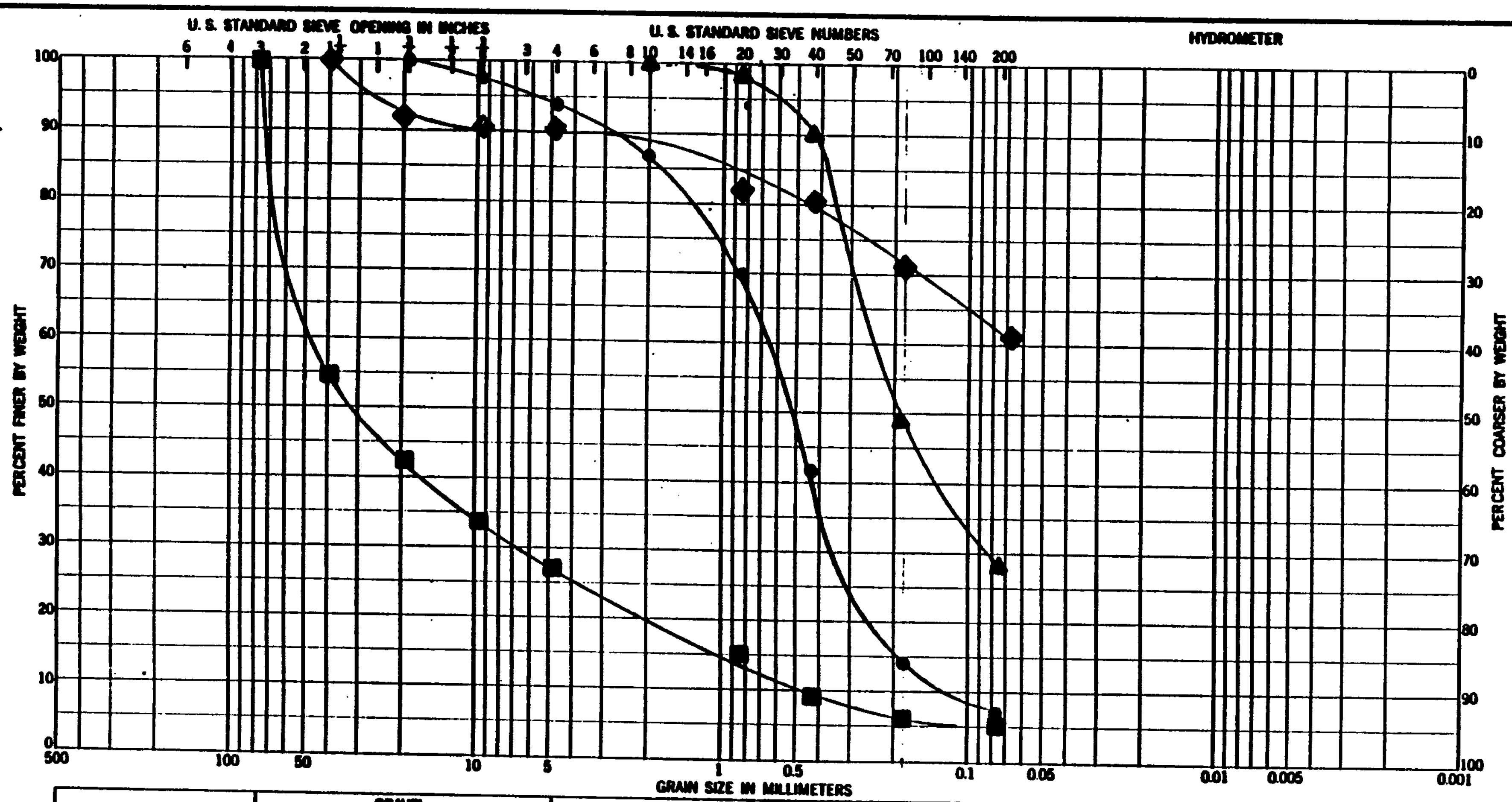
Date November 1986

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-22

27



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
80-22M(7) ■	11.6	SANDY GRAVEL (GP) ~ (Lower Alluv)				
80-22M(9) ●	19.3	SAND W/TRACE GRAVEL (SW) ~ (L.A)				
80-23M(2) ▲	1.6	SILTY FINE SAND (SM) (FILL)				
80-23M(3) ◆	6.4	SANDY CLAY W/GRAVEL (CL)(FILL)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

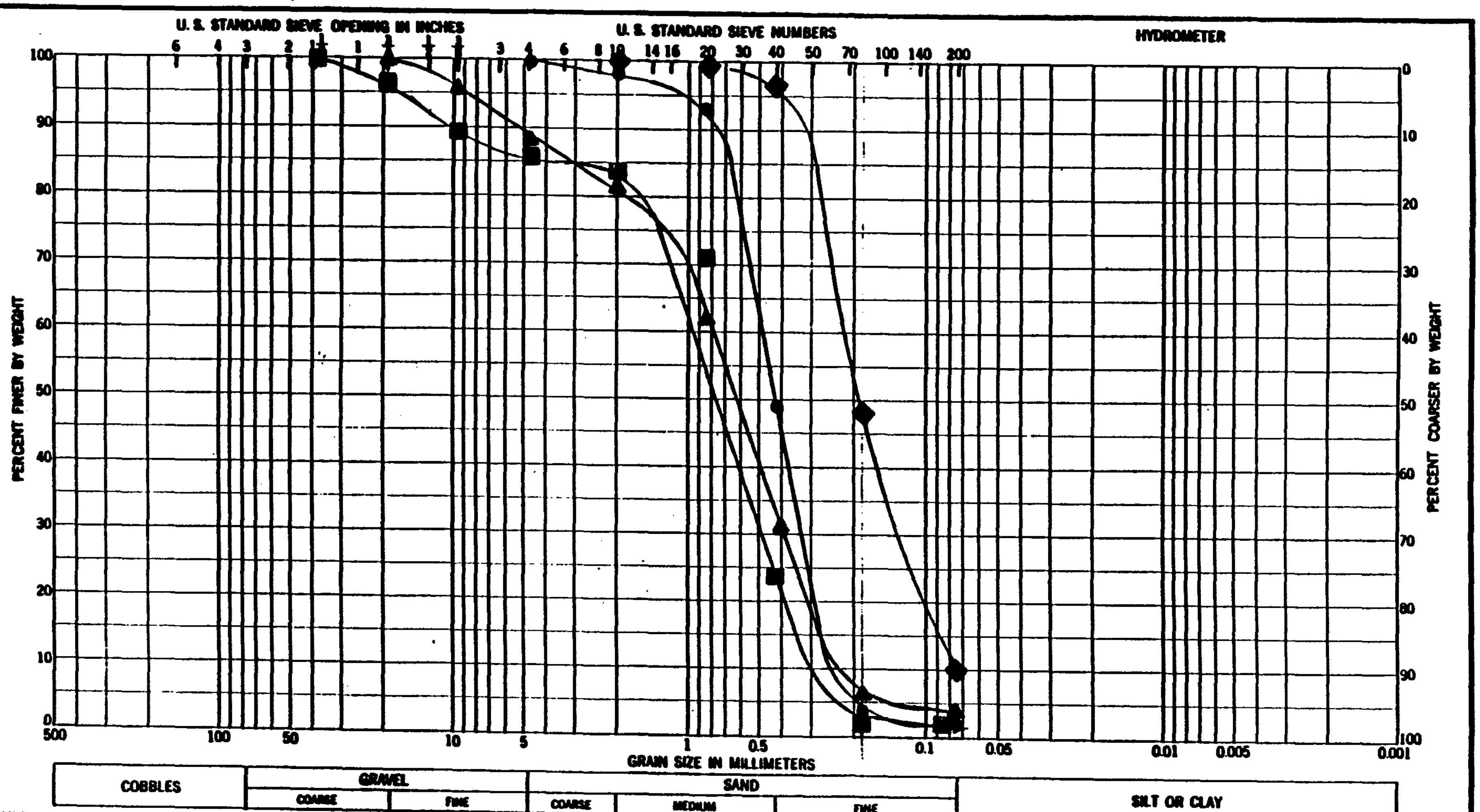
Boring No. 80-22M & 80-23M

Date NOVEMBER 1986

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-23



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
81-32M(3) ●	10.8	SAND (SP) ~ (UPPER ALLUVIUM)				
81-32M(4) ▲	16.3	SAND W/GRAVEL (SP) ~ (Lower Al.)				
81-44M(2) ■	5.9	SAND W/GRAVEL (SP) ~ (UPPER Al.)				
81-44M(3) ◆	9.2	FINE SAND W/TRACE SILT (SP) ~ (UPPER ALL)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

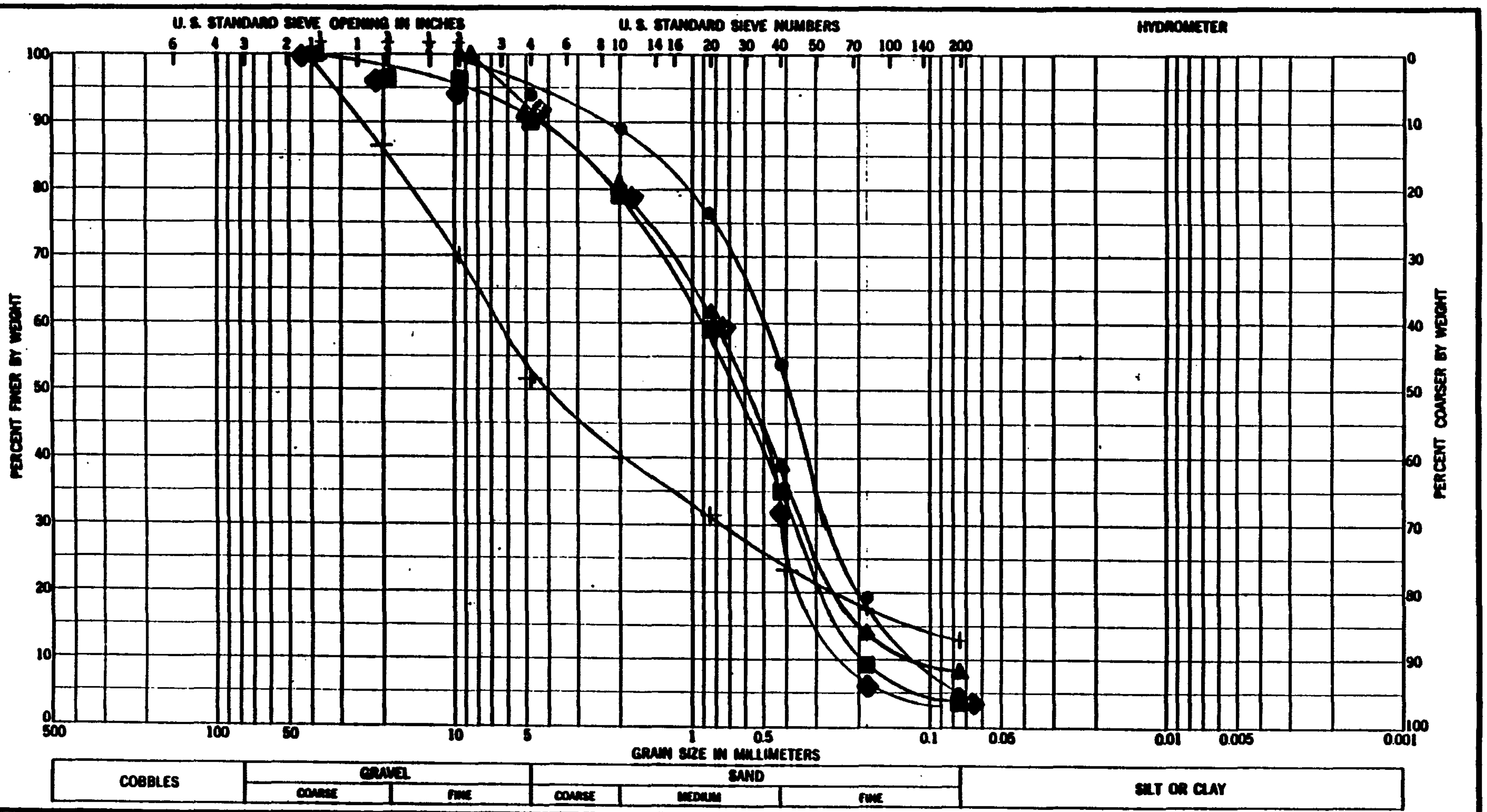
Boring No. 81-32M & 81-44M

Date N[illegible]MBER 1986

GRADATION CURVE[illegible]

ENG FORM [illegible] 1 MAY 63

PLATE B-24



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
81-44M (4) ●	14.0	FINE SAND (SP) ~ (UPPER Al.)				
81-44M (6) ■	24.0	SAND W/GRAVEL (SW) ~ (Low Alluv.)				
81-44M (8) ▲	33.9	SAND (SW) ~ (Lower Alluv.)				
81-44M (11) ◆	44.3	SAND (SW) ~ (Lower Alluvium)				
81-44M (14) +	56.4	SILTY SANDY GRAVEL (GM) ~ (L.A.)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

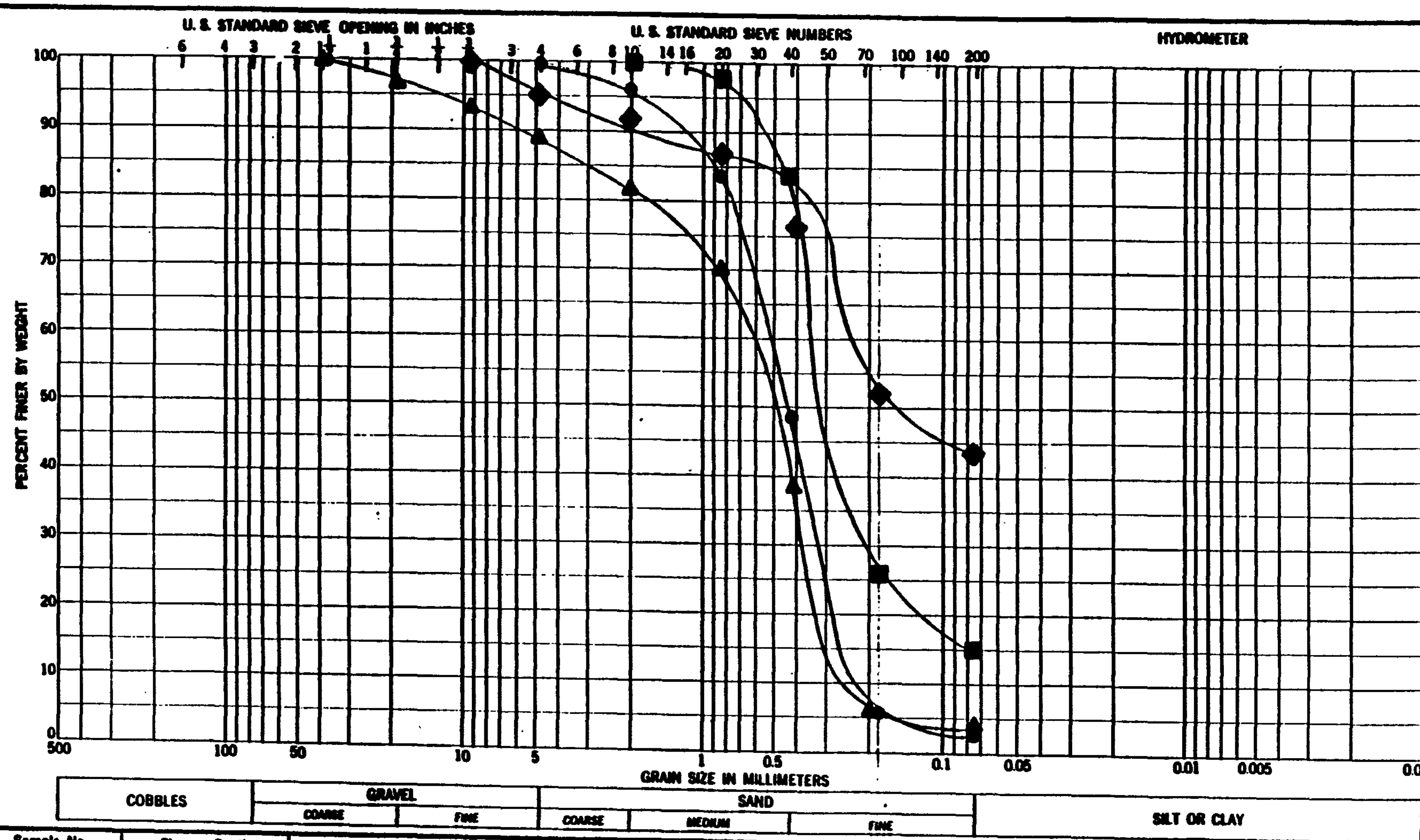
Boring No. 81-44M

Date NOVEMBER 1986

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-25



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
83-52M(1) ■	3.0	SILTY FINE SAND (SM)~(FILL)				
83-54M(3) ◆	11.5	CLAYEY SAND (SC-SP)~(FILL)				
83-54M(4) ●	13.5	SAND (SP)~(UPPER Alluvium)				
83-54M(6) ▲	20.5	SAND W/GRAVEL (SP)~Lower Alluv.				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

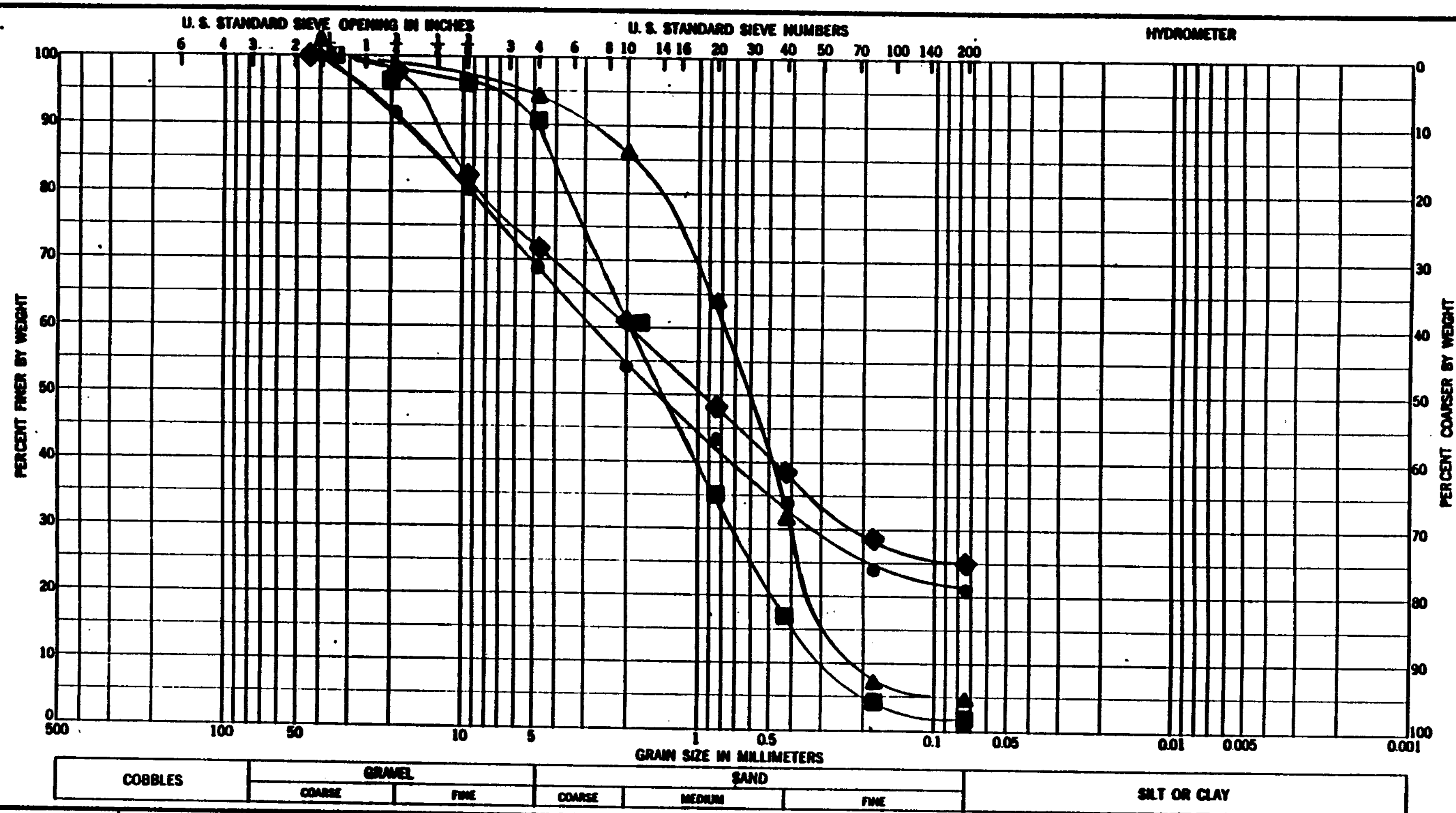
Area REACH 1B

Boring No. 83-52M & 83-54M

Date NOVEMBER 1986

GRADATION CURVES

ENG FORM 1 MAY 63



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
83-55M (2) ●	6.5	SILTY SAND W/GRAVEL (SM)(FILL)				
83-55M (3) ◆	10.5	SILTY SAND W/GRAVEL (SM)(FILL)				
83-55M (4) ■	16.5	SAND W/GRAVEL (SW) - (Lower Alluv				
83-55M (5) ▲	21.5	SAND W/TRACE GRAVEL (SP) ~ (Lower Alluv)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

Boring No. 83-55M

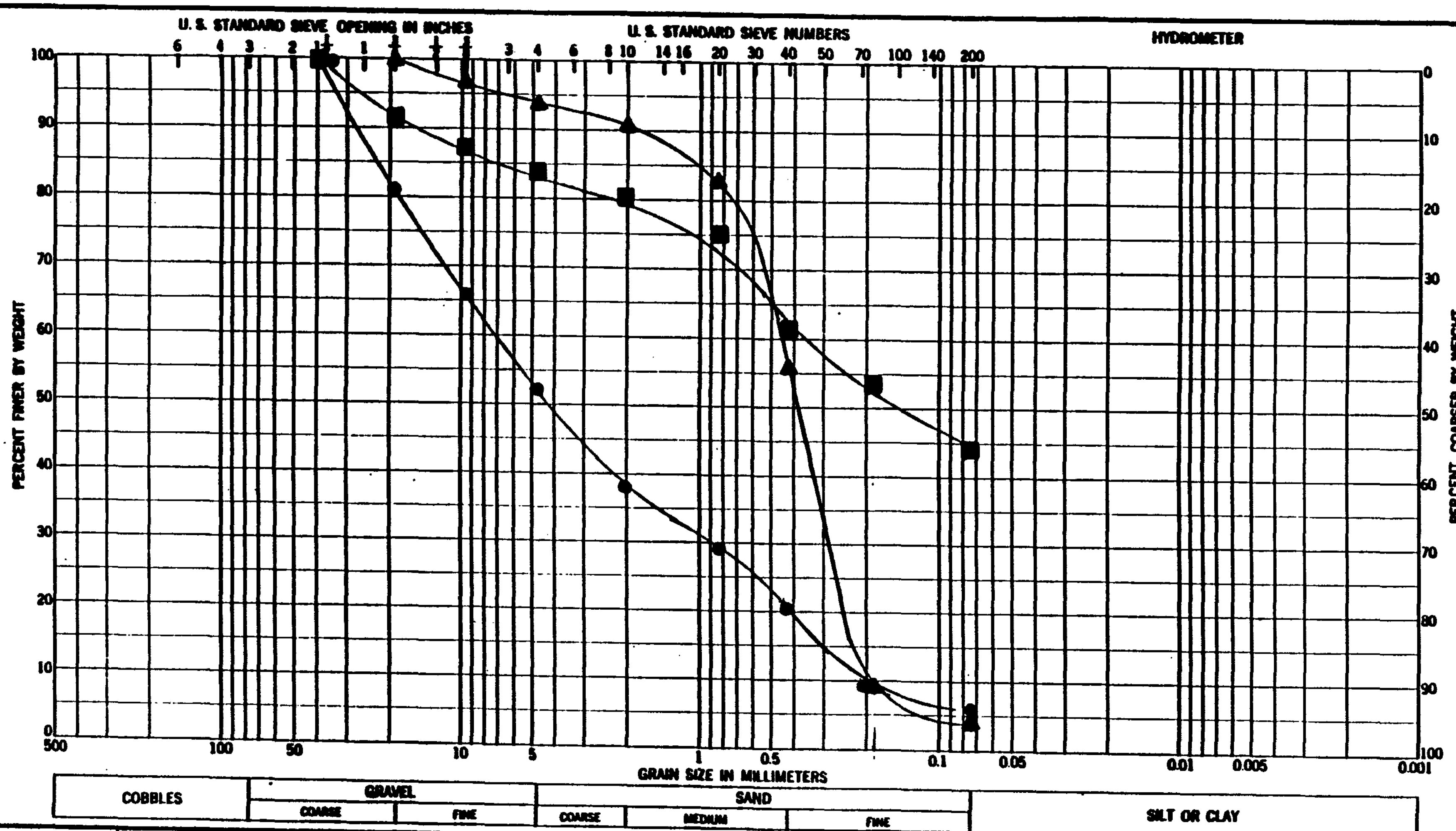
Date NOVEMBER 1986

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-27

27



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
83-56M(1) ■	1.5	SILTY SAND W/GRAVEL (SM)-(FILL)				
83-56M(2) ▲	6.5	SAND W/GRAVEL (SP)-(UPPER All.)				
83-56M(3) ●	11.5	SANDY GRAVEL (GW)-(Lower All.)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

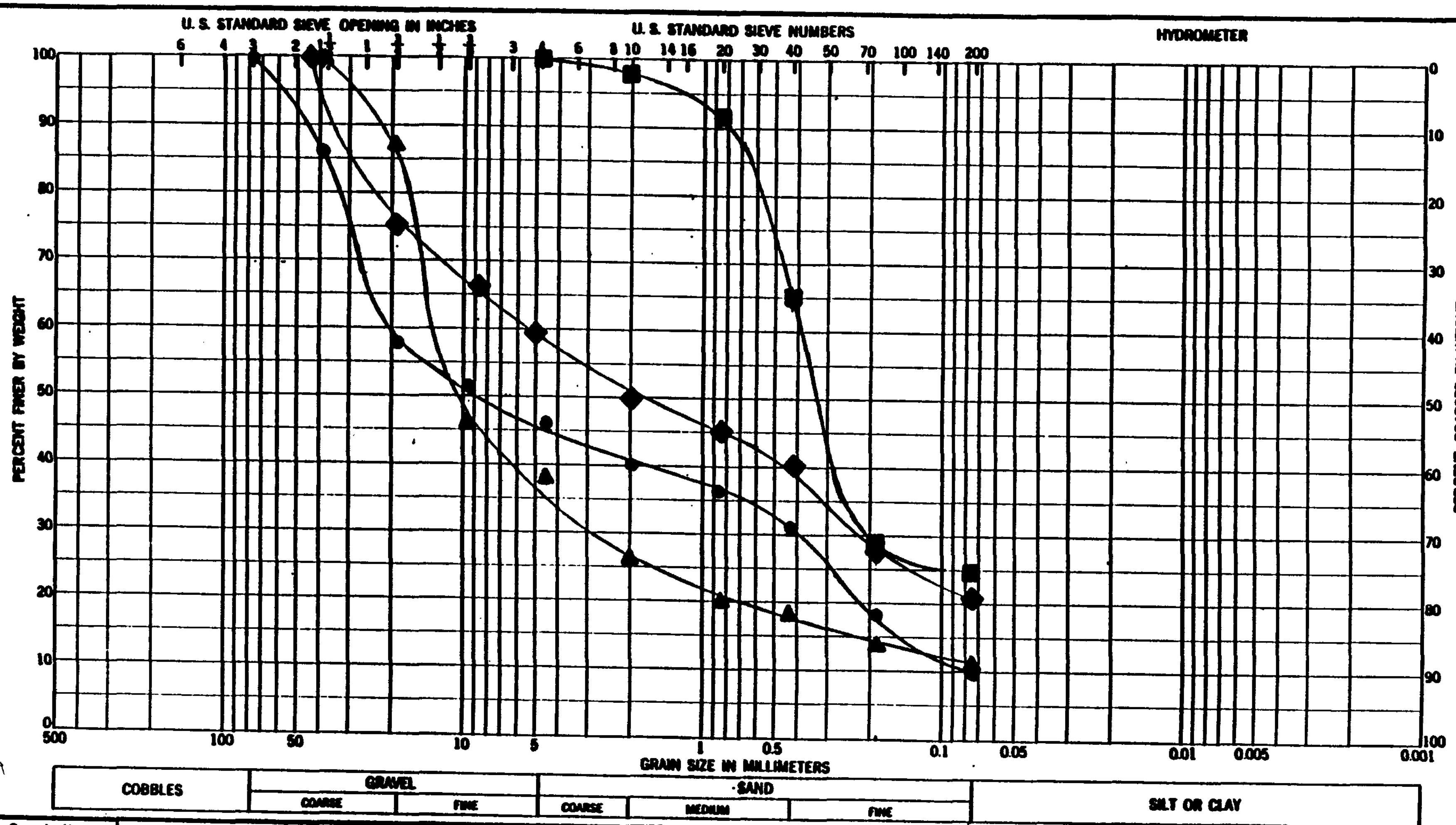
Boring No. 83-56M

Date NOVEMBER 1986

GRADATION CURVES

ENG FORM 1 MAY 63 2'

PLATE B-28



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
83-57M(2) ■	6.5	SILTY FINE SAND (SM)-(FILL)?				
83-57M(5) ▲	16.5	SANDY GRAVEL/ROCK FRAG. (GP)-(L.A.)				
83-61M(2) ●	6.5	SANDY GRAVEL (GP-GM)-(Low Al.				
83-61M(3) ◆	11.5	SILTY SANDY GRAVEL (GM)-(Lower Alluvium)				

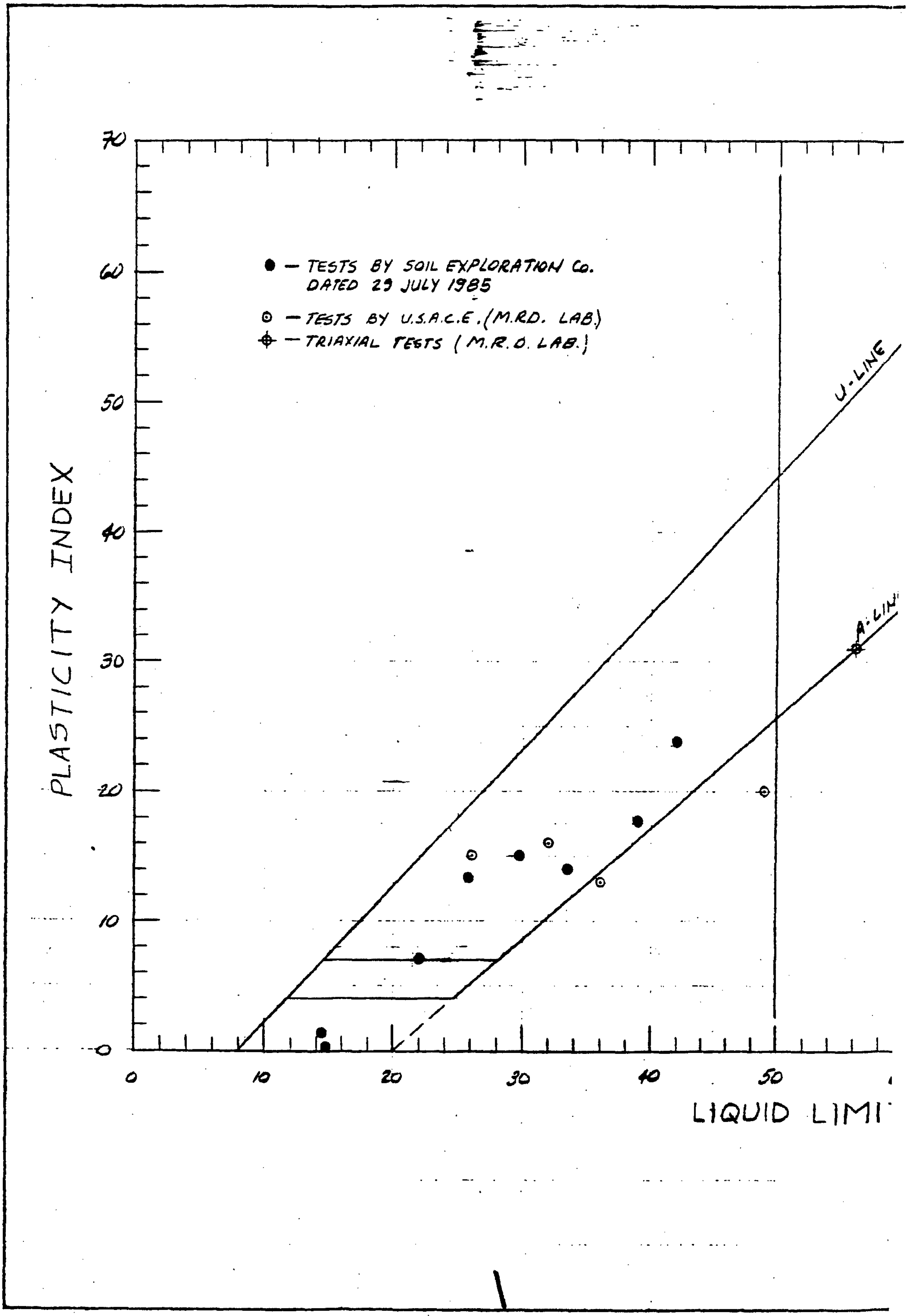
Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.
Area REACH 1B
Boring No. 83-57M & 83-61M
Date NOVEMBER 1986

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-29

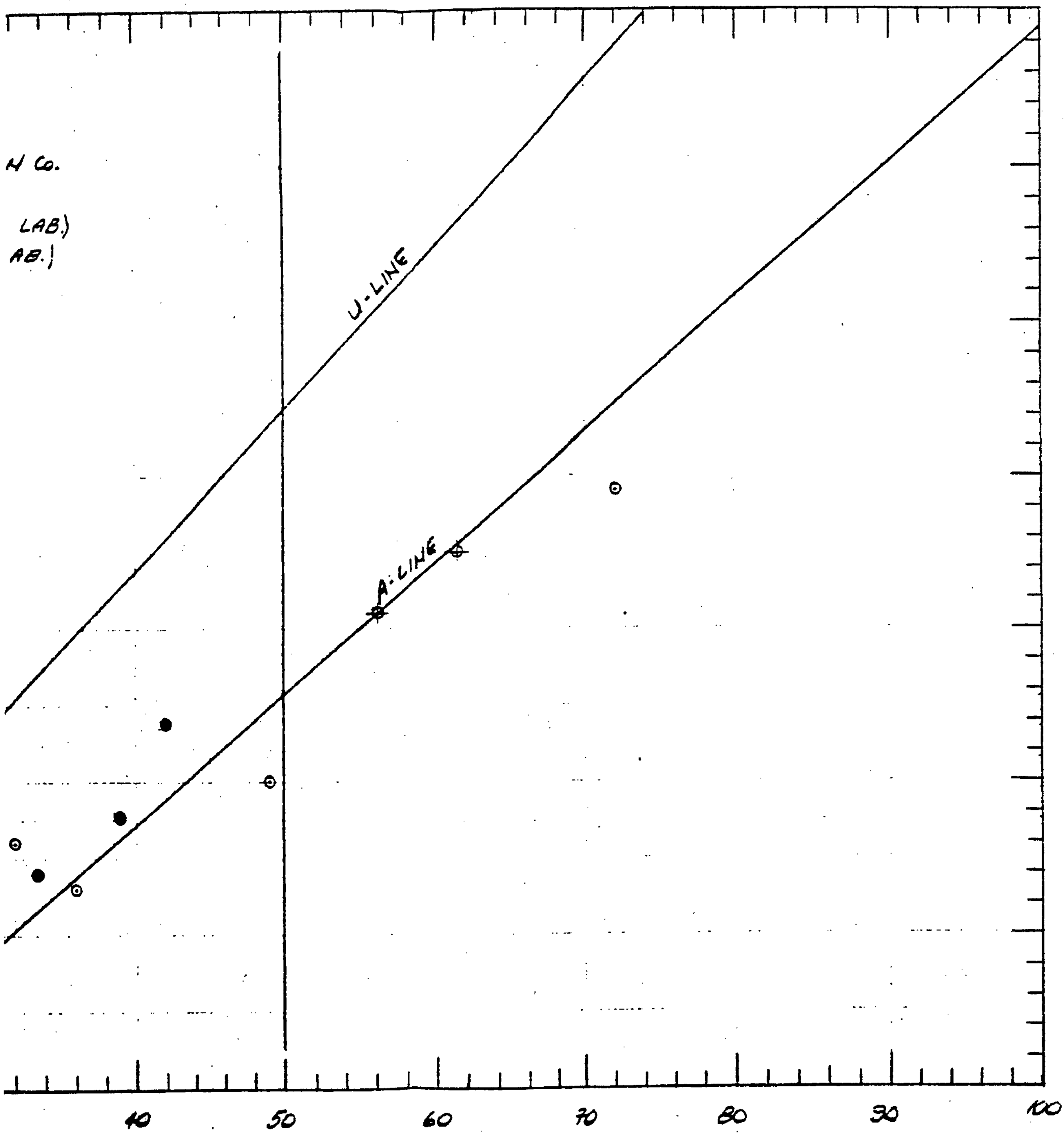
29



● — TESTS BY SOIL EXPLORATION Co. DATED 29 JULY 1985
⊙ — TESTS BY U.S.A.C.E. (M.RD. LAB)
⊕ — TRIAXIAL TESTS (M.R.D. LAB.)
U-LINE
A-LIN
PLASTICITY INDEX
LIQUID LIMI
0
10
20
30
40
50
60
70

N Co.

LAB.)
AB.)

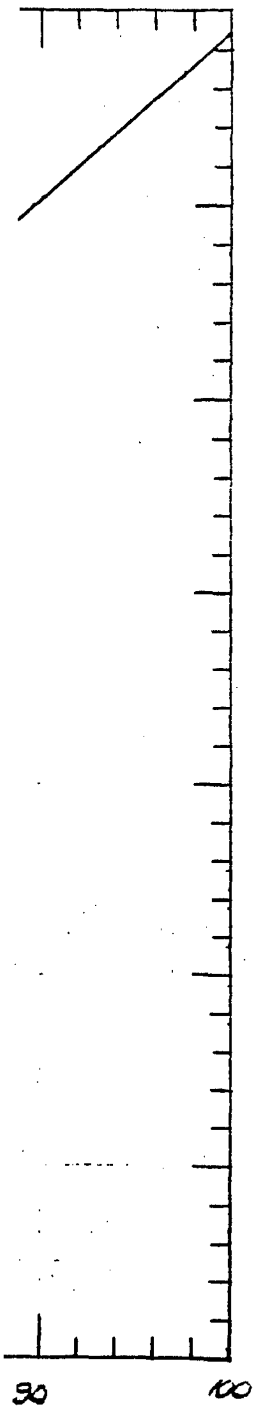


LIQUID LIMIT

DESI

St.
File

2



DESIGN MEMORANDUM NO. 2 PHASE IB , - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

PLASTICITY CHART

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-36

3

SOIL C

Project: Rochester Flood Control: Reach 1B FDM

Station: -

Range: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	P.I.	Grading (Cumulative Per — Hyd. Analsis — Fines .005	.02mm	200	U.S. Standard S — Sand 80	40	20	10	
83-55	M	Composite of Sacks 1 and 2 (FILL)										
	10.0						24	29	43	58	76	
83-57	M	Composite of Sacks 1 and 2 (FILL/UPPER ALLUVIUM										
	7.0	27	14				35	39	64	91	98	1
84-68	M	Composite of Sacks 1 and 2 (FILL)										
	10.0	27	14				44	55	78	93	99	1
84-68	M	Composite of Sacks 3 and 4 (FILL/UPPER ALLUVIUM										
	18.0						28	36	76	92	97	
84-77	M	Composite of Sacks 1 and 2 (FILL)										
	10.0						16	29	95	100		
84-77	M	Composite of Sacks 3 and 4 (LOWER ALLUVIUM)										
	18						16	26	69	85	92	
84-78	M	Composite of Sacks 1 and 2 (FILL)										
	8.0	36	17				37	48	72	86	94	1
84-78	M	Composite of Sacks 7 and 8 (LOWER ALLUVIUM)										
	20.0	—					5	8	38	75	90	
84-80	M	Composite of Sacks 1 and 2 (FILL/FINE-GRAINED A										
	13.0	21	11				30	42	83	95	99	1

MRD FORM 16
NOV. 75 EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

...M		Boring No: Misc. bag samples	MRD L...
...nge: -	Surf. Elev: -	Depth To Water Table: -	Bottor...

...s	Grading (Cumulative Percents Finer)										Gradation Curve Analysis					Classification
...lsis	U. S. Standard Sieve Sizes															
...s		Sand					Gravel									
...m	200	80	40	20	10	4	3/8	3/4	1 1/2	3 in	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	*Tech. MEMO 3-357, May 6...*
	2	(FILL)														
	24	29	43	58	76	88	98	100								Silty sand SM
	2	(FILL/UPPER ALLUVIUM)														
	35	39	64	91	98	100										Clayey sand SC
	2	(FILL)														
	44	55	78	93	99	100										Clayey sand SC
	4	(FILL/UPPER ALLUVIUM)														
	28	36	76	92	97	98	99	100								Silty sand SM
	2	(FILL)														
	16	29	95	100												Silty sand SM
	4	(LOWER ALLUVIUM)														
	16	26	69	85	92	97	100									Silty sand SM
	2	(FILL)														
	37	48	72	86	94	100										Clayey sand SC
	8	(LOWER ALLUVIUM)														
	5	8	38	75	90	95	98	99	100		0.60	0.35	0.20	3.0	1.0	Sand SP
	2	(FILL/FINE-GRAINED ALLUVIUM)														
	30	42	83	95	99	100										Clayey sand SC

DESIGN MEMORA...

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St. Paul Dist...
File No.

IEET

Boring No: Misc. bag samples	MRD Lab. No:
Depth To Water Table: -	Bottom Of Hole: -

Analysis		Classification	Remarks
C_u	C_c	*Tech. MEMO 3-357, May 67*	PL
		Silty sand SM	
		Clayey sand SC	13
		Clayey sand SC	13
		Silty sand SM	
		Silty sand SM	
		Silty sand SM	
		Clayey sand SC	Glass, cinders wood in gravel portion 19
3.0	1.0	Sand SP	
		Clayey sand SC	10

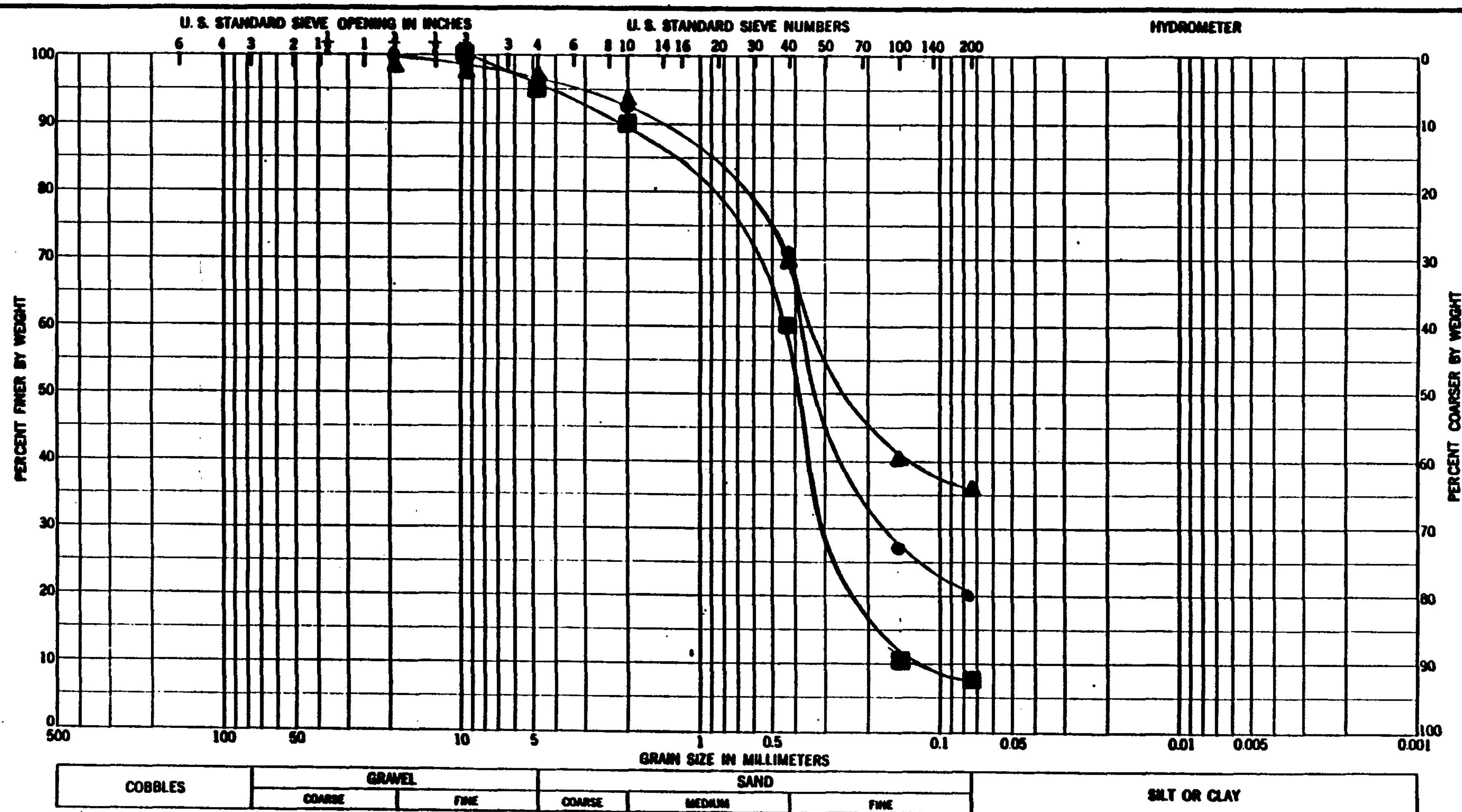
DESIGN MEMORANDUM NO. 2 PHASE 1B, - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CLASSIFICATION TESTS SUMMARY
DIRECT SHEAR TEST SAMPLES

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-37

3

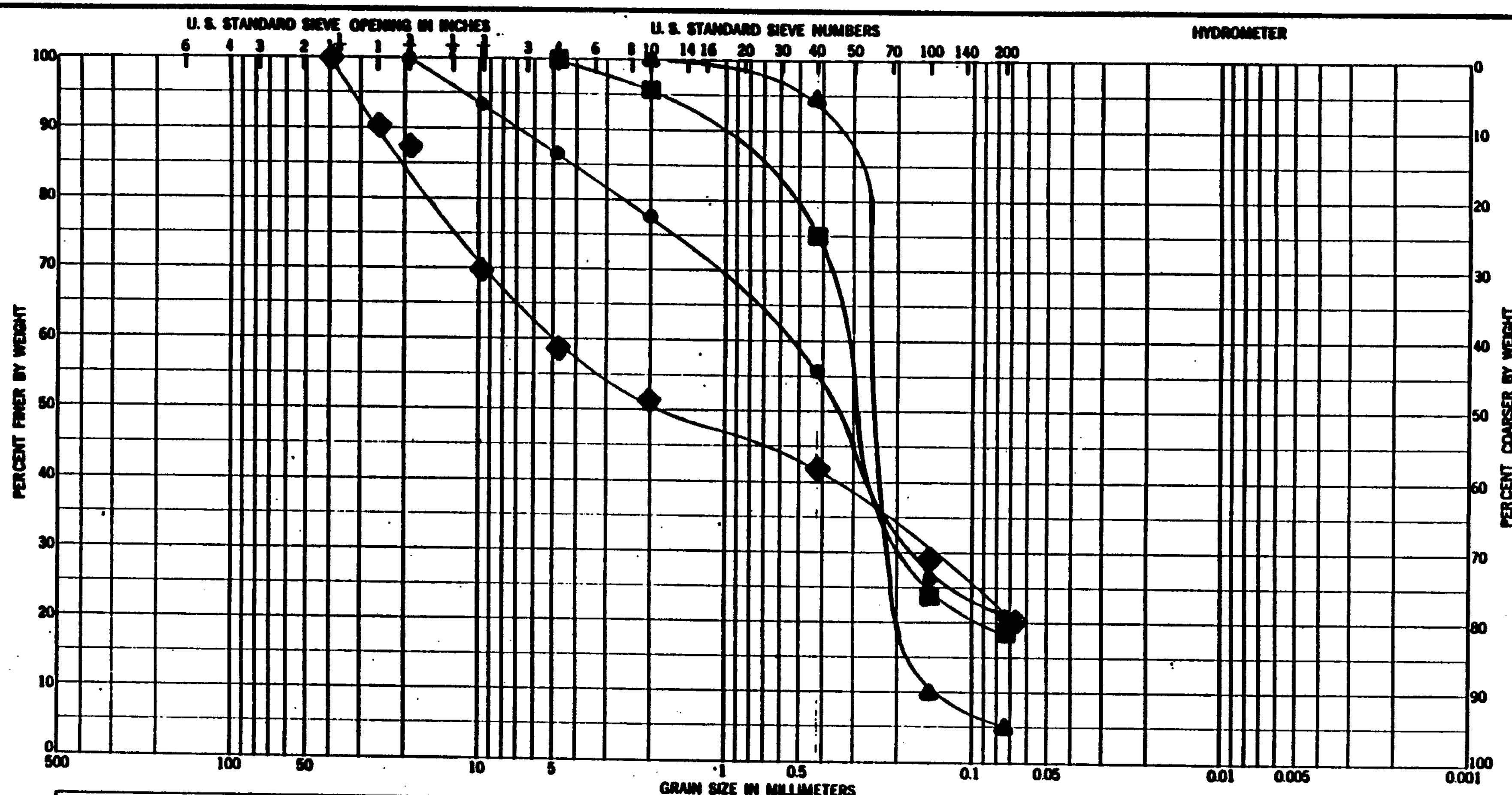


Sample No.		Elev or Depth	Classification	Nat w %	LL	PL	PI
2	●	4.0-4.5	CLAYEY SAND (SC)~(UPPER ALLU.				
3	▲	5.5-6.5	CLAYEY SAND (SC-SM)-(U.A.)				
4	■	8-9	SAND (SP-SM)-(UPPER ALLUVIUM)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO RIVER
Area REACH 1B
Boring No. 84-65M
Date

GRADATION CURVES

ENG FORM 1 MAY 63 7



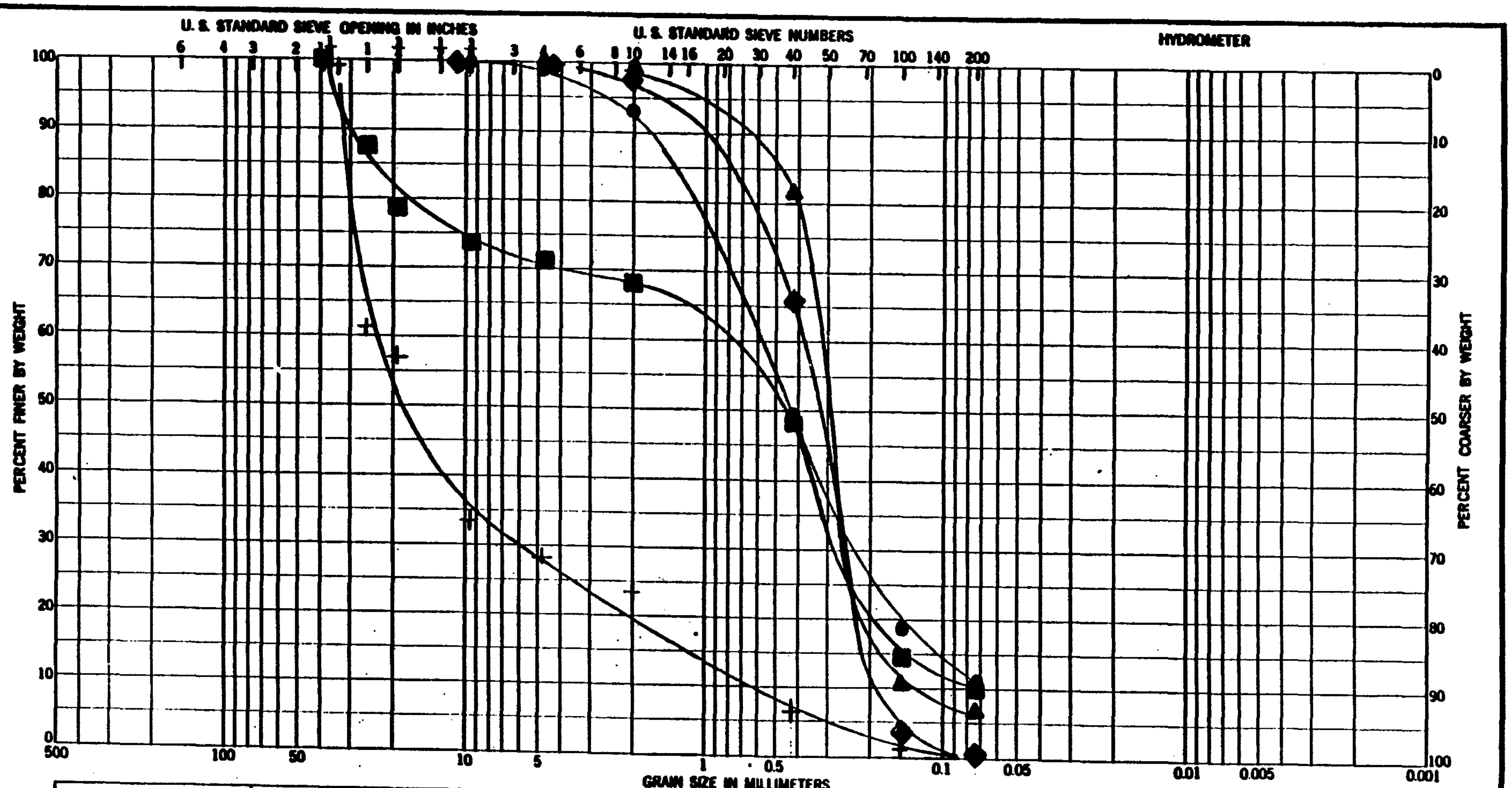
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
84-66M (1) ●	1-2	SILTY SAND (SM) ~ (FILL)				
84-66M (4) ▲	13.5-14.5	SAND (SP) ~ (UPPER Alluvium)				
84-67M (1) ■	3-4	SILTY SAND (SM) ~ (FILL)				
84-67M (2) ◆	5.5-6.2	SILTY SAND (SM) ~ (FILL)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.
Area REACH 1B
Boring No. 84-66M & 84-67M
Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-31



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
84-68M (4) ●	13.5-15.0	SAND W/SILT (SM)~(FILL)				
84-74M (2) ■	1.0-1.9	SAND W/SILT & GR (SP-SM)(FILL)				
84-74M (3) ▲	1.9-2.3	SAND W/SILT (SP-SM)~(UPPER AL)				
84-74M (5) ◆	6.5-7.5	SAND (SP)~(UPPER ALLUVIUM)				
84-74M (7) +	10-10.7	GRAVEL (GP)~(LOWER ALLUV.)				

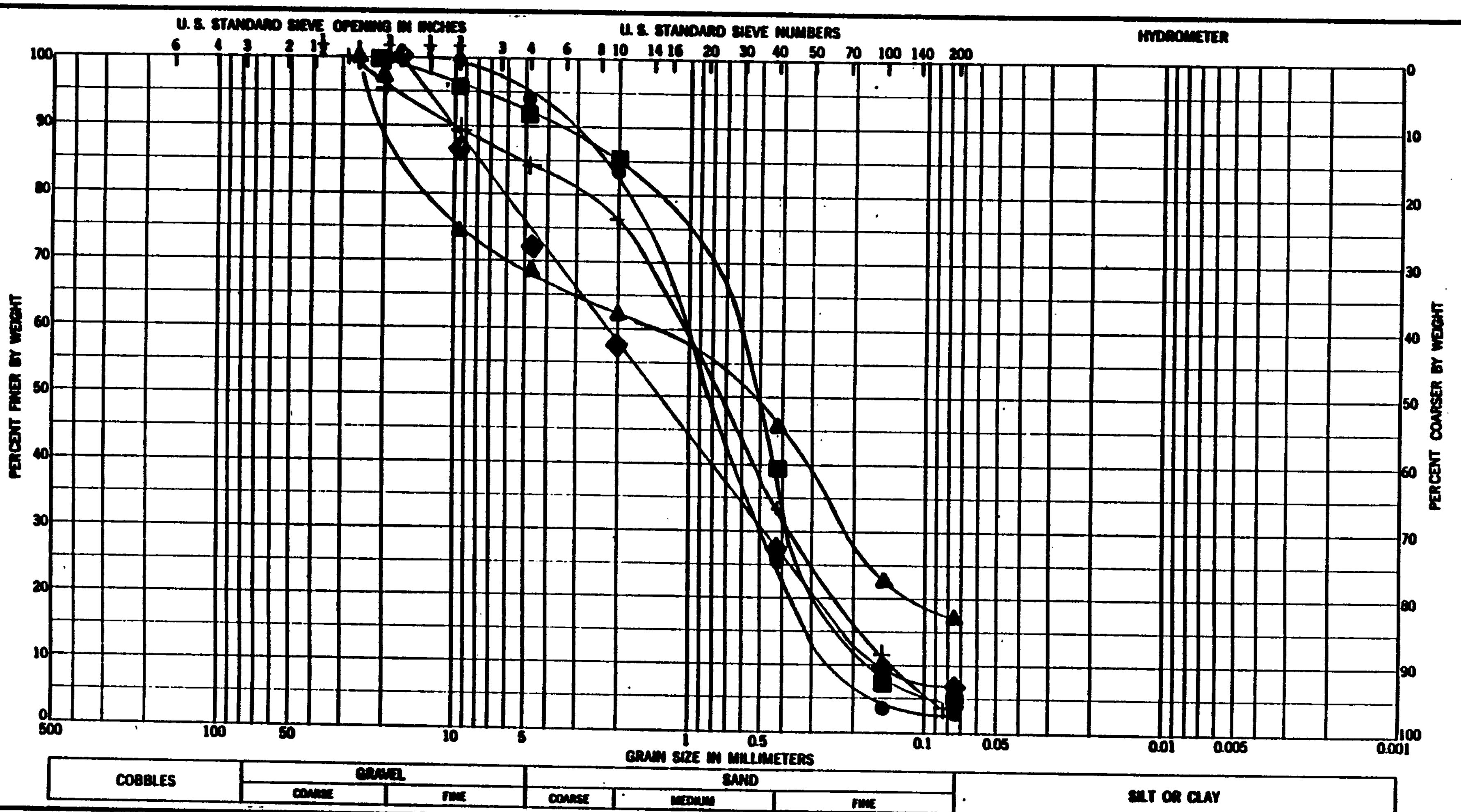
Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO RIVER
Area REACH 1B
Boring No. 84-68M & 84-74M
Date

GRADATION CURVES

ENG FORM 1 MAY 63 - 7

PLATE B-32

32



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
84-74M (8) ●	16-17	SAND W/TRACE GRAVEL (SW)~(UP. AL.)				
84-74M (7) ■	18-19	SAND W/TRACE GRAVEL (SP)~(L. A.)				
84-75M (3) ▲	5-6	SILTY SAND W/GRAVEL (SM)-(FILL)				
84-75M (6) ◆	13-14	SAND W/SILT & GRAVEL (SP-SM)-(FILL)				
84-75M (7) +	16-17	SAND W/GRAVEL (SW)~(Lower AL)				

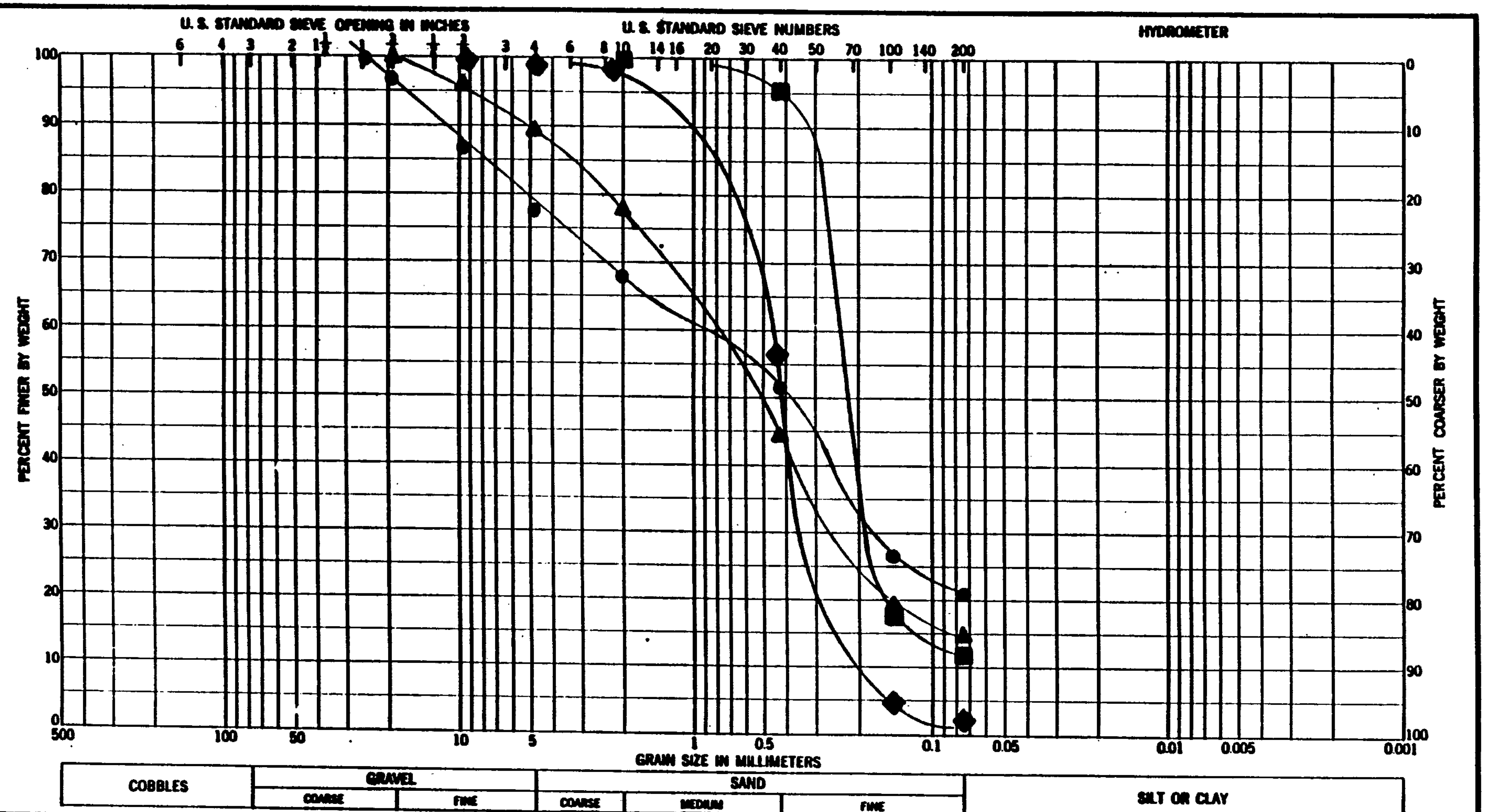
Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.
Area REACH 1B
Boring No. 84-74M & 84-75M
Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-33

33



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
84-77M (2) ●	1.5-2.5	SILTY SAND W/GRAVEL (SM)-(FILL)				
84-77M (3) ■	9-10	SAND W/SILT (SP)-(UPPER AL.)				
84-80M (3) ▲	10-11	SILTY SAND W/TRACE GR. (SM)-(FILL)				
84-80M (6) ◆	16.5-17.3	SAND (SP)-(UPPER ALLUVIUM)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

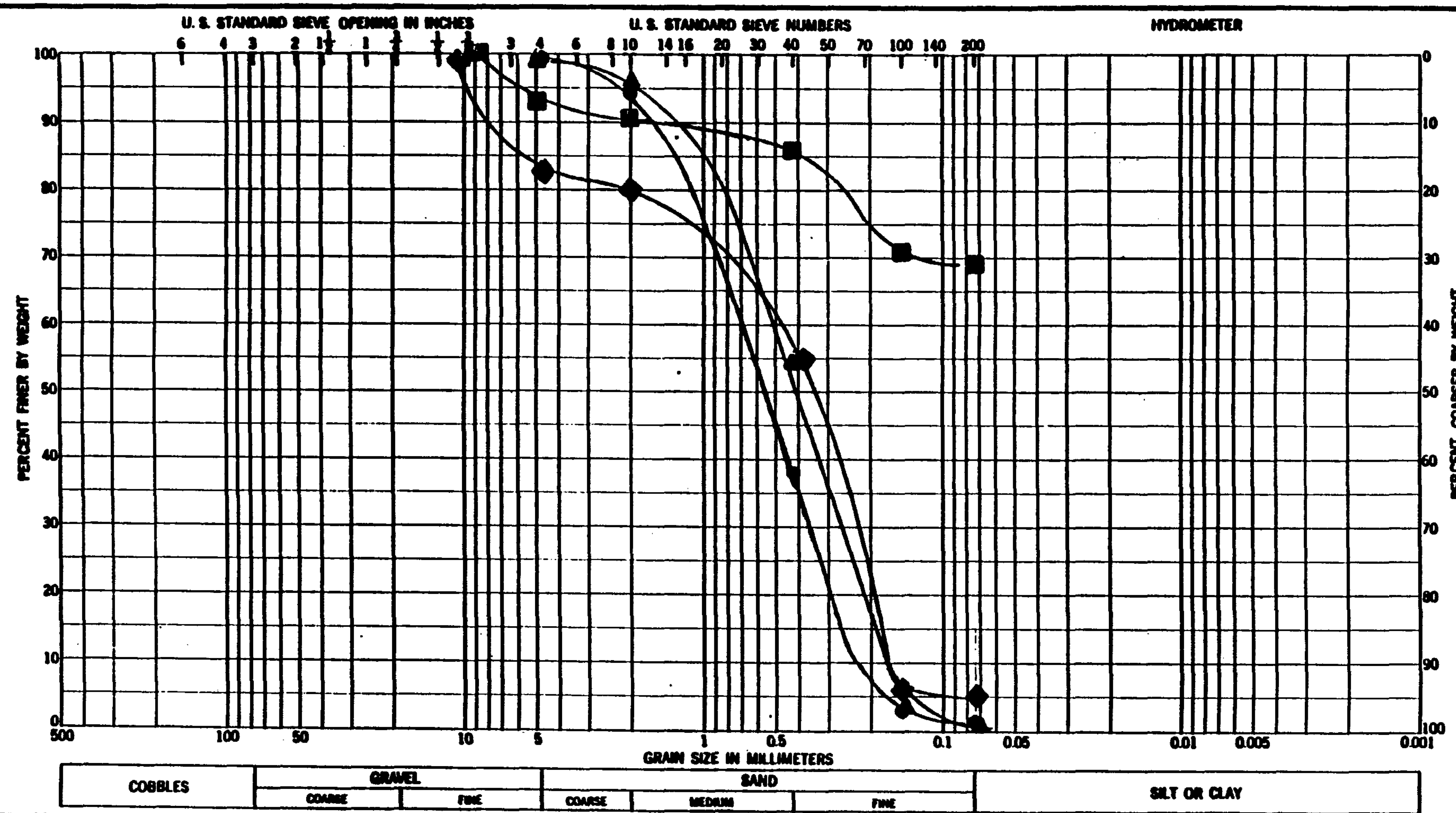
Boring No. 84-77M & 84-80M

Date

GRADATION CURVE

ENG FORM 1 MAY 63 7

PLATE B-34



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
B4-82M(1) ●	3-4	SAND (SP) ~ (UPPER Alluvium)				
B4-82M(2) ▲	6.3-6.7	SAND (SP) ~ (UPPER Alluvium)				
B4-88M(1) ■	0-0.3	CLAY (CL/OL) W/SAND & GRAVEL ~ (U.A)				
B4-88M(5) ◆	8-9	SAND (SP-SM) W/GRAVEL ~ (Low. Al.)				

Project ROCHESTER FLOOD CONTROL
S. FORK ZUMBRO R.

Area REACH 1B

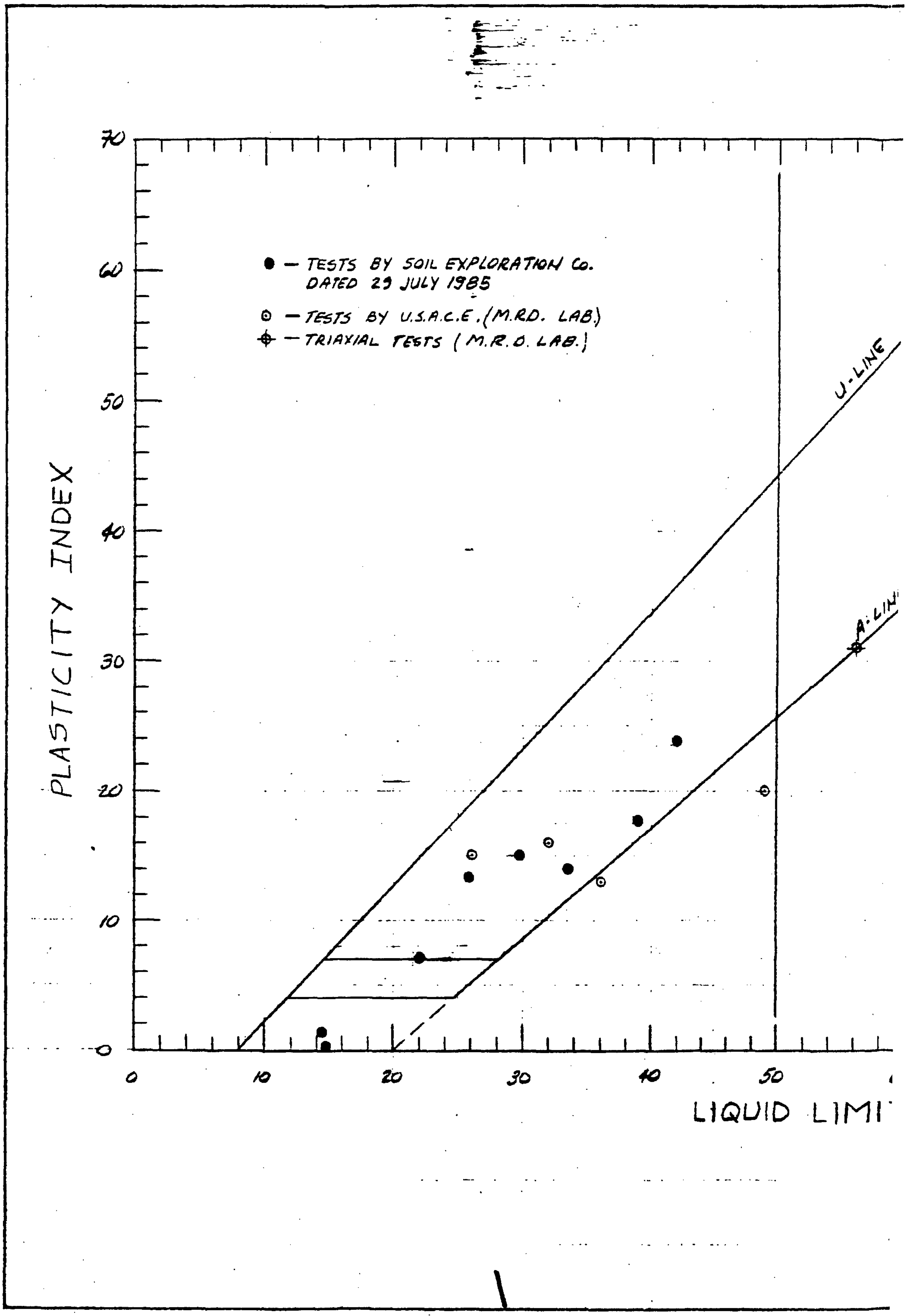
Boring No. B4-82M & B4-88M

Date

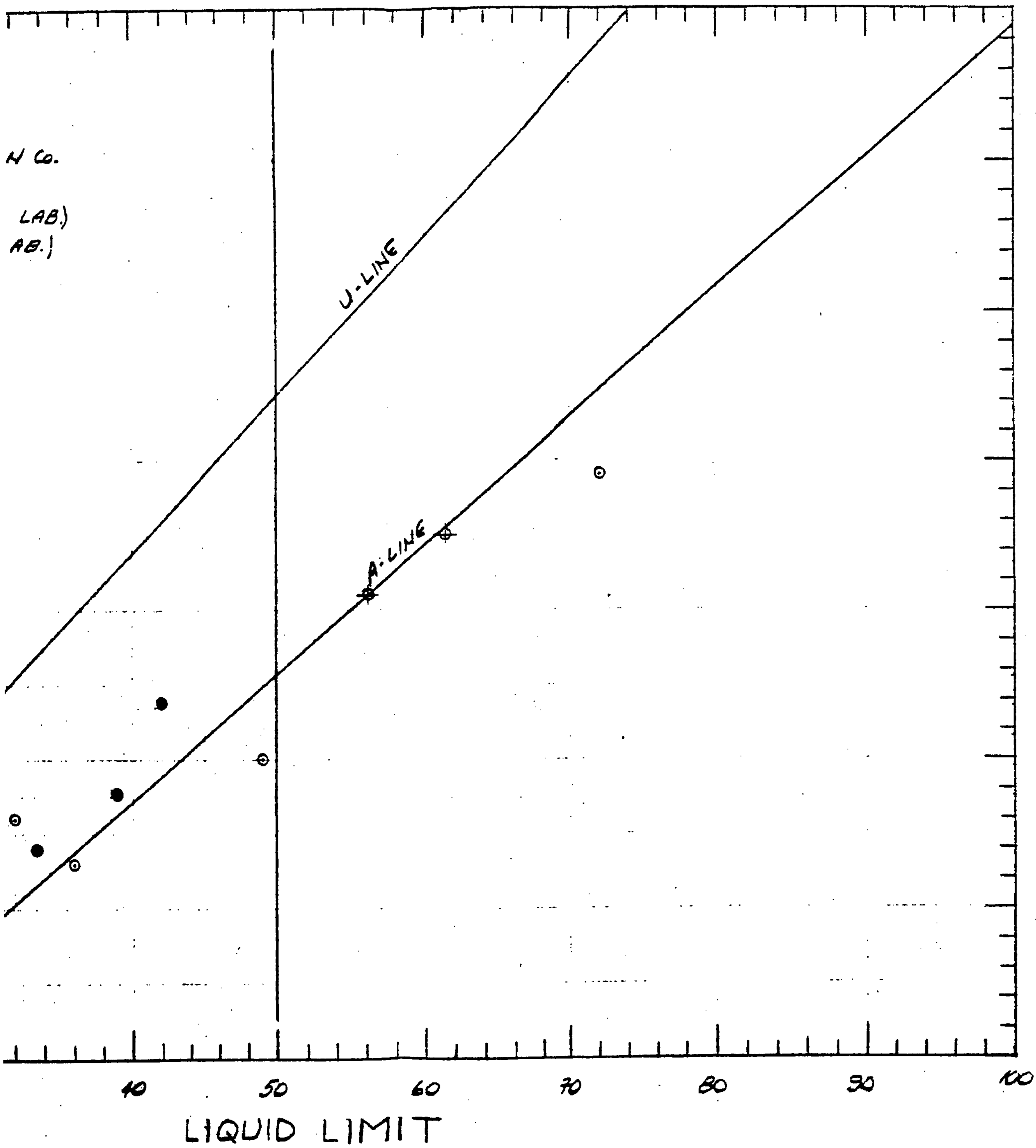
GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-35



● — TESTS BY SOIL EXPLORATION Co. DATED 29 JULY 1985
⊙ — TESTS BY U.S.A.C.E. (M.R.D. LAB)
⊕ — TRIAXIAL TESTS (M.R.O. LAB.)
U-LINE
PLASTICITY INDEX
0
10
20
30
40
50
60
70
LIQUID LIMI



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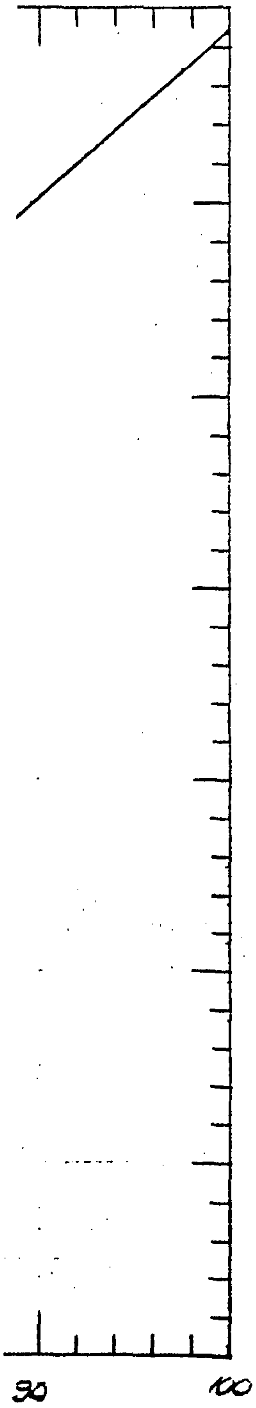
File

2



DESIGN MEMORANDUM NO. 2 PHASE /B . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

PLASTICITY CHART

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-36

3

SOIL CI

Project: Rochester Flood Control: Reach 1B FDM

Station: -

Range: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Per — Hyd. Analsis — Fines .005	.02mm	200	U.S. Standard S — Sand 80	40	20	10	
83-55	M	Composite of Sacks 1 and 2 (FILL)										
	10.0						24	29	43	58	76	
83-57	M	Composite of Sacks 1 and 2 (FILL/UPPER ALLUVIUM										
	7.0	27	14				35	39	64	91	98	1
84-68	M	Composite of Sacks 1 and 2 (FILL)										
	10.0	27	14				44	55	78	93	99	1
84-68	M	Composite of Sacks 3 and 4 (FILL/UPPER ALLUVIUM										
	18.0						28	36	76	92	97	
84-77	M	Composite of Sacks 1 and 2 (FILL)										
	10.0						16	29	95	100		
84-77	M	Composite of Sacks 3 and 4 (LOWER ALLUVIUM)										
	18						16	26	69	85	92	
84-78	M	Composite of Sacks 1 and 2 (FILL)										
	8.0	36	17				37	48	72	86	94	1
84-78	M	Composite of Sacks 7 and 8 (LOWER ALLUVIUM)										
	20.0	—					5	8	38	75	90	
84-80	M	Composite of Sacks 1 and 2 (FILL/FINE-GRAINED A										
	13.0	21	11				30	42	83	95	99	1

SOIL CLASSIFICATION RECORD SHEET

ƆM		Boring No: Misc. bag samples	MRD L
ıge: -	Surf. Elev: -	Depth To Water Table: -	Bottor

Grading (Cumulative Percents Finer)											Gradation Curve Analysis					Classification	
lsis	U. S. Standard Sieve Sizes																
s		Sand					Gravel										
m	200	80	40	20	10	4	3/8	3/4	1 1/2	3 in	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	*Tech. MEMO 3-357, May 6*	
	2	(FILL)															
	24	29	43	58	76	88	98	100								Silty sand	SM
	2	(FILL/UPPER ALLUVIUM)															
	35	39	64	91	98	100										Clayey sand	SC
	2	(FILL)															
	44	55	78	93	99	100										Clayey sand	SC
	4	(FILL/UPPER ALLUVIUM)															
	28	36	76	92	97	98	99	100								Silty sand	SM
	2	(FILL)															
	16	29	95	100												Silty sand	SM
	4	(LOWER ALLUVIUM)															
	16	26	69	85	92	97	100									Silty sand	SM
	2	(FILL)															
	37	48	72	86	94	100										Clayey sand	SC
	8	(LOWER ALLUVIUM)															
	5	8	38	75	90	95	98	99	100		0.60	0.35	0.20	3.0	1.0	Sand	SP
	2	(FILL/FINE-GRAINED ALLUVIUM)															
	30	42	83	95	99	100										Clayey sand	SC

DESIGN MEMORA

CLA
DI

St. Paul Dist
File No.

IEET

Boring No: Misc. bag samples	MRD Lab. No:
Depth To Water Table: -	Bottom Of Hole: -

Analysis		Classification		Remarks
C_u	C_c	*Tech. MEMO 3-357, May 67*		PL
		Silty sand	SM	
		Clayey sand	SC	13
		Clayey sand	SC	13
		Silty sand	SM	
		Silty sand	SM	
		Silty sand	SM	
		Clayey sand	SC	Glass, cinders wood in gravel portion 19
3.0	1.0	Sand	SP	
		Clayey sand	SC	10

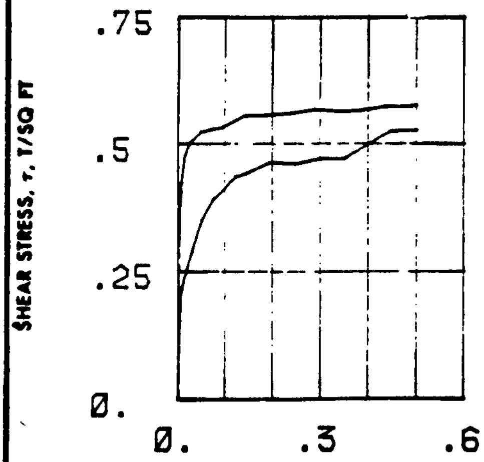
DESIGN MEMORANDUM NO. 2 PHASE 1B, - FEATURE
APPENDIX B - GEOTEC

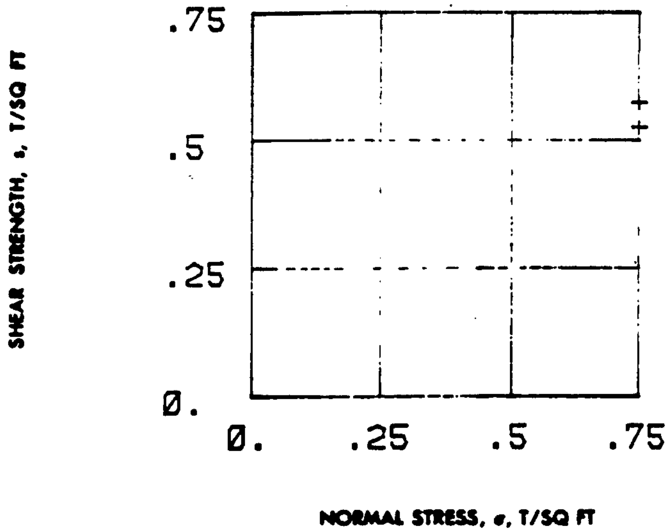
FLOOD CONTROL
ROCHESTER, MINNESOTA

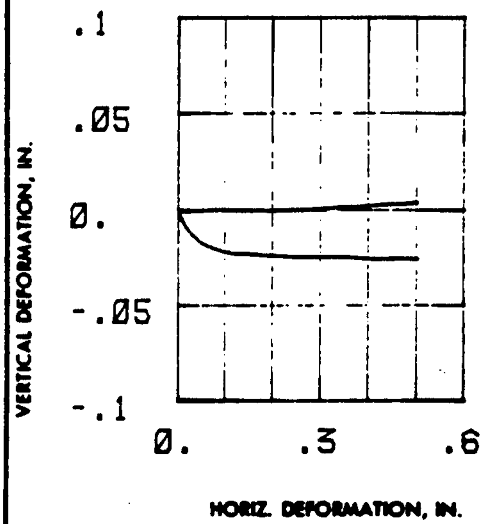
CLASSIFICATION TESTS SUMMARY
DIRECT SHEAR TEST SAMPLES

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-37

3







SHEAR STRENGTH PARAMETERS

φ' = ____________

TAN φ' = ____________

c' = ____________ T/SQ FT

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

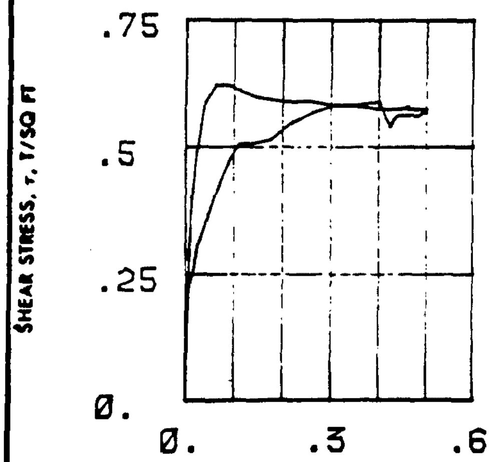
TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	3.3 %	7.5 %	%	%
	VOID RATIO	e_o	1.11	.41		
	SATURATION	S_o	8. %	49. %	%	%
	DRY DENSITY, LB/CU FT	γ_d	79.8	119.1		
VOID RATIO AFTER CONSOLIDATION		e_c	1.11	.41		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	15.7 %	14.4 %	%	%
	VOID RATIO	e_f	1.06	.43		
	SATURATION	S_f	40. %	92. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.528	.576		
ACTUAL TIME TO FAILURE, MIN		t_f	1265	1260		
RATE OF STRAIN, IN./MIN X .0001			3.95	3.94		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.528	.576		

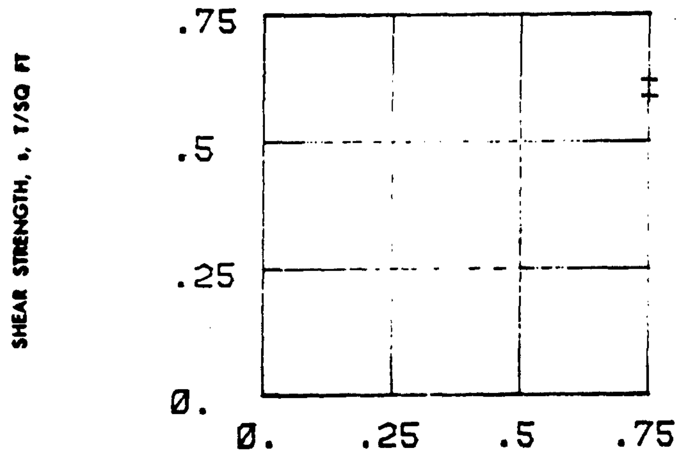
TYPE OF SPECIMEN Remolded		3. IN. SQUARE		1. IN. THICK
CLASSIFICATION Silty sand, SM				
LL	PL	PI		G_s 2.7 Assumed

REMARKS

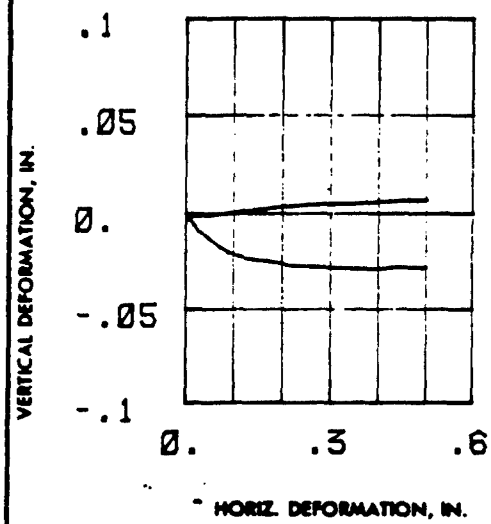
PROJECT	ROCHESTER; NCS-IA-86-85-ED-GH
AREA	MRD LAB NO: 86/216
BORING NO. 83-55	SAMPLE NO. Sacks 1 & 2
DEPTH EL 4-10	DATE

DIRECT SHEAR TEST REPORT





NORMAL STRESS, σ, T/SQ FT



TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	2.5 %	10.7 %	%	%
	VOID RATIO	e_o	1.08	.38		
	SATURATION	S_o	6.4 %	77. %	%	%
	DRY DENSITY, LB/CU FT	γ_d	81.	122.5		
VOID RATIO AFTER CONSOLIDATION		e_c	1.08	.38		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	15.6 %	14.1 %	%	%
	VOID RATIO	e_f	1.02	.38		
	SATURATION	S_f	41. %	100. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.591	.622		
ACTUAL TIME TO FAILURE, MIN		t_f	1020	240		
RATE OF STRAIN, IN./MIN		X .0001	3.93	3.6		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.530	.575		

SHEAR STRENGTH PARAMETERS

φ' = __________

TAN φ' = __________

c' = __________ T/SQ FT

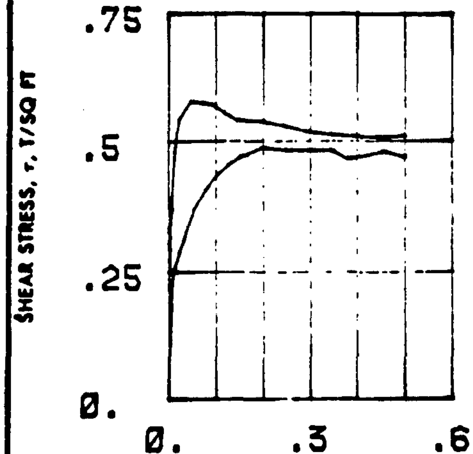
☐ CONTROLLED STRESS

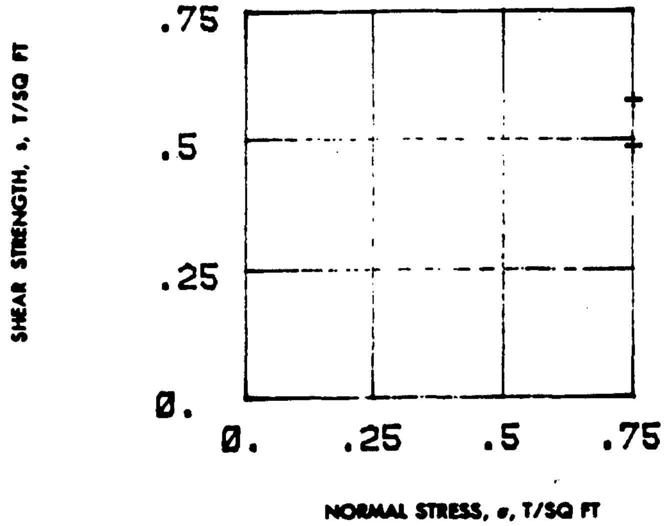
☒ CONTROLLED STRAIN

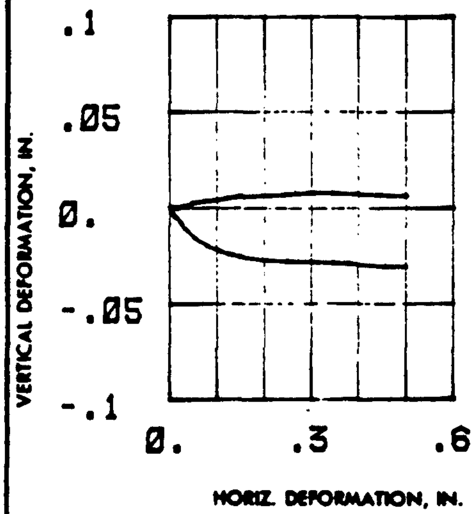
TYPE OF SPECIMEN REMOLDED		3. IN. SQUARE	.990 IN. THICK
CLASSIFICATION Clayey sand, SC			
LL 14	PL 13	PI 1	G_s 2.7 Assumed

REMARKS	PROJECT ROCHESTER, MN; NCS-IA-88-65-ED-GH	
	AREA MRD LAB NO: 86/216	
	BORING NO. 83-57M	SAMPLE NO. Sacks 1 & 2
	DEPTH EL 1-7	DATE

DIRECT SHEAR TEST REPORT







TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	2. %	11.9 %	%	%
	VOID RATIO	e_o	1.02	.47		
	SATURATION	S_o	5.4 %	60. %	%	%
	DRY DENSITY, LB/CU FT	γ_d	85.5	114.4		
VOID RATIO AFTER CONSOLIDATION		e_c	1.02	.47		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	20.4 %	17.0 %	%	%
	VOID RATIO	e_f	.90	.40		
	SATURATION	S_f	57. %	100. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.487	.570		
ACTUAL TIME TO FAILURE, MIN		t_f	420	120		
RATE OF STRAIN, IN./MIN X .0001			4.02	3.02		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.484	.506		

SHEAR STRENGTH PARAMETERS

φ' = ________

TAN φ' = ________

c' = ________ T/SQ FT

☐ CONTROLLED STRESS

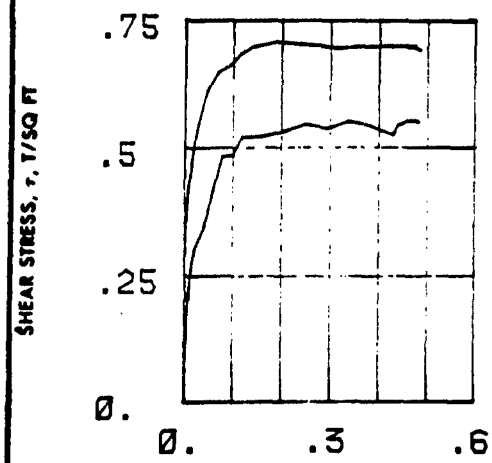
☒ CONTROLLED STRAIN

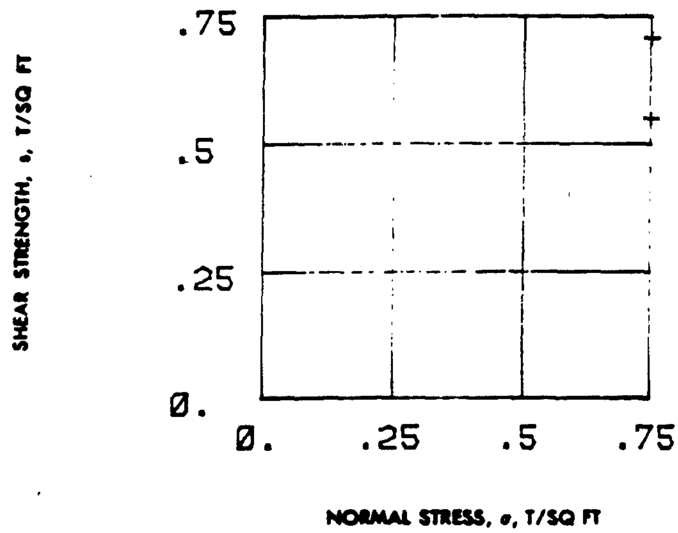
TYPE OF SPECIMEN REMOLDED		3. IN. SQUARE	1. IN. THICK
CLASSIFICATION Clayey sand, SC			
LL 14	PL 13	PI 1	G_s 2.7 Assumed

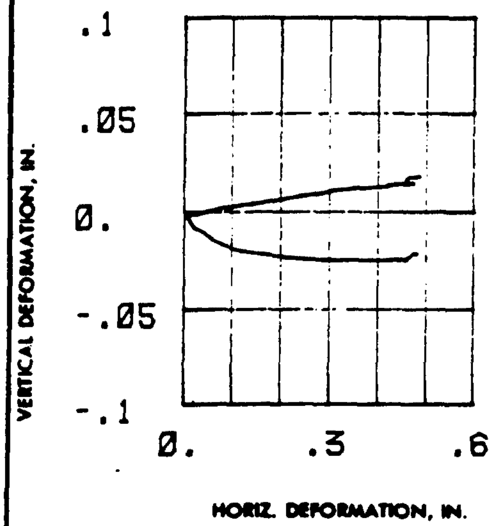
REMARKS

PROJECT ROCHESTER,MN; NCS-IA-[illegible]	
AREA MRO LAB NO: [illegible]/218	
BORING NO. [illegible]	SAMPLE NO. Sacks 1 & 2
DEPTH EL 2.[illegible]-1[illegible]	DATE

DIRECT SHEAR TEST REPORT







TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	7.9 %	15.6 %	%	%
INITIAL	VOID RATIO	e_o	1.66	.45		
INITIAL	SATURATION	S_o	13. %	94. %	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	63.4	116.6		
VOID RATIO AFTER CONSOLIDATION		e_c	1.07	.45		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	18.8 %	15.8 %	%	
FINAL	VOID RATIO	e_f	1.01	.46		
FINAL	SATURATION	S_f	50. %	92. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.553	.708		
ACTUAL TIME TO FAILURE, MIN		t_f	1440	420		
RATE OF STRAIN, IN./MIN		X .0001	3.28	4.47		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.549	.692		

SHEAR STRENGTH PARAMETERS

ϕ' = ______________

TAN ϕ' = ______________

c' = ______________ T/SQ FT

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

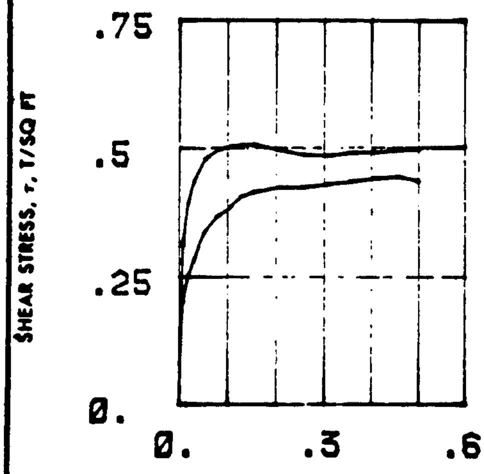
TYPE OF SPECIMEN REMOLDED	3. IN. SQUARE	.95 IN. THICK	
CLASSIFICATION Silty sand, SM			
LL	PL	PI	G. 2.7 Assumed

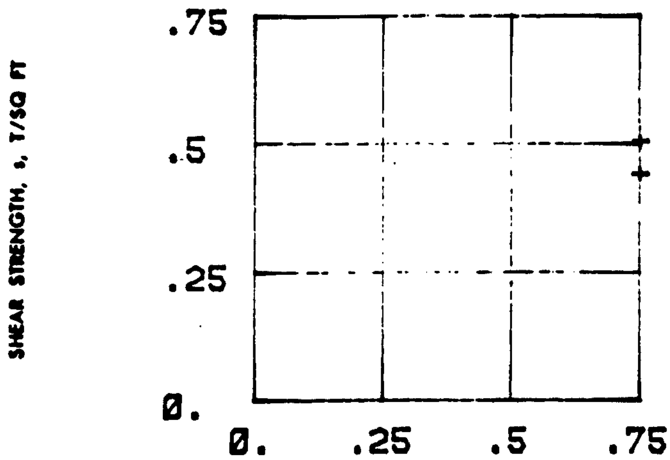
REMARKS ______________________

PROJECT ROCHESTER, MN; NCS-IR-[illegible]-[illegible]-ED-GH	
AREA MRD LAB NO: 86/216	
BORING NO. 84-68	SAMPLE NO. sacks 3 & 4
DEPTH EL 10-18	DATE

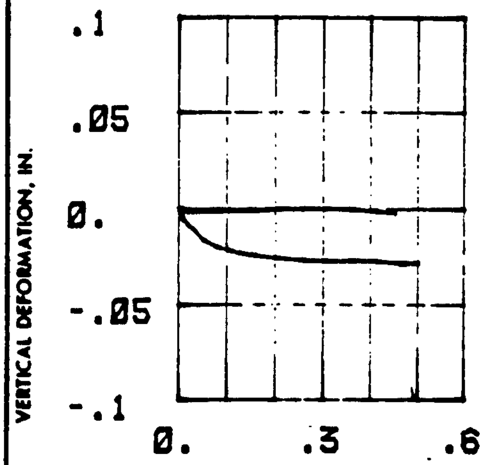
DIRECT SHEAR TEST REPORT

ENG FORM 1 JUN 65 **2092** *(EM 1110-2-1906)* PREVIOUS EDITIONS ARE OBSOLETE *(TRANSLUCENT)* GPO : 1966 OF—214-846 PLATE IX-3





NORMAL STRESS, σ, T/SQ FT



HORIZ. DEFORMATION, IN.

			1	2		
TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	.98 %	5.8 %	%	%
INITIAL	VOID RATIO	e_o	1.09	.55		
INITIAL	SATURATION	S_o	2.4 %	28. %	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	80.7	108.5		
VOID RATIO AFTER CONSOLIDATION		e_c	1.09	.55		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	18.5 %	16.1 %	%	%
FINAL	VOID RATIO	e_f	1.05	.55		
FINAL	SATURATION	S_f	47. %	79. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.444	.506		
ACTUAL TIME TO FAILURE, MIN		t_f	1020	380		
RATE OF STRAIN, IN./MIN		X .0001	4.44	4.2		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.456	.485		

SHEAR STRENGTH PARAMETERS

φ′ = ____________

TAN φ′ = ____________

c′ = ____________ T/SQ FT

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TYPE OF SPECIMEN REMOLDED	5. IN. SQUARE	1. IN. THICK	
CLASSIFICATION Silty sand, SM			
LL	PL	PI	G_s 2.7 Assumed

REMARKS ____________

PROJECT ROCHESTER, MN; NCS-IR-88-86-ED-GH

AREA MRD LAB NO: 88/216

BORING NO. 84-77M

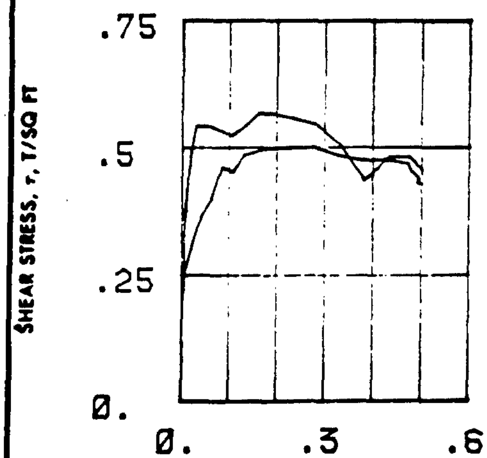
SAMPLE NO. sacks 1 & 2

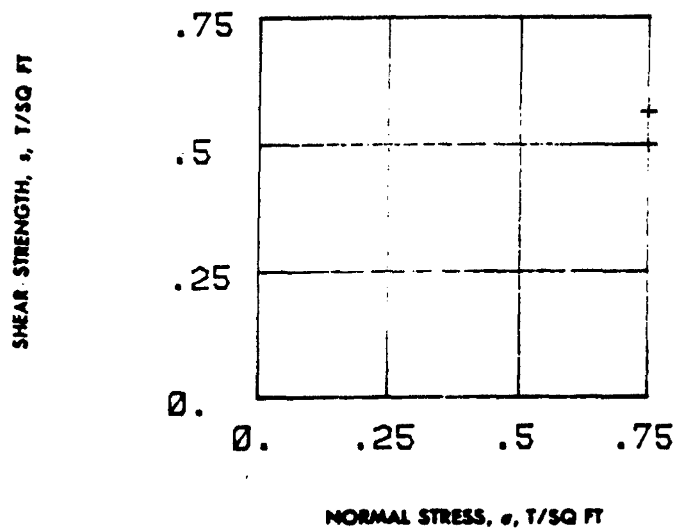
DEPTH EL 5-10

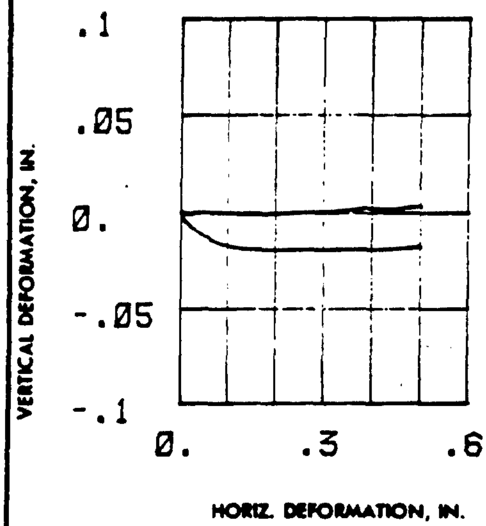
DATE

4

DIRECT SHEAR TEST REPORT PLATE B-42







TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	3. %	7.1 %	%	%
	VOID RATIO	e_o	1.29	.46		
	SATURATION	S_o	6.2 %	42. %	%	%
	DRY DENSITY, LB/CU FT	γ_d	73.6	115.5		
VOID RATIO AFTER CONSOLIDATION		e_c	1.29	.46		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	16.7 %	16. %	%	
	VOID RATIO	e_f	1.25	.46		
	SATURATION	S_f	36. %	95. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.5	.567		
ACTUAL TIME TO FAILURE, MIN		t_f	660	360		
RATE OF STRAIN, IN./MIN		X .0001	4.17	5.17		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.427	.434		

SHEAR STRENGTH PARAMETERS

φ' = ____________

TAN φ' = ____________

c' = ____________ T/SQ FT

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TYPE OF SPECIMEN	Remolded	3. IN. SQUARE	.998 IN. THICK	
CLASSIFICATION	Silty sand, SM			
LL	PL	PI		G_s 2.7 Assumed

REMARKS ____________

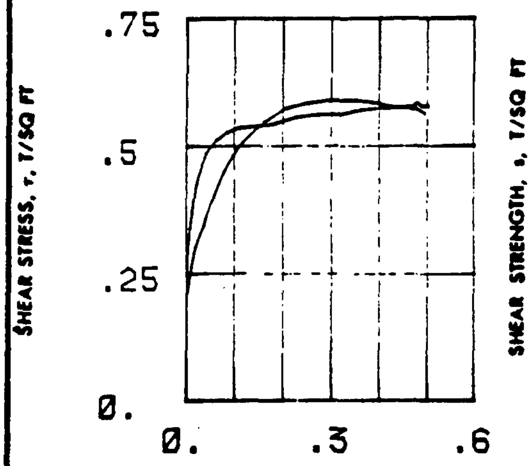
PROJECT ROCHESTER; NCS-IA-80-05-ED-GH

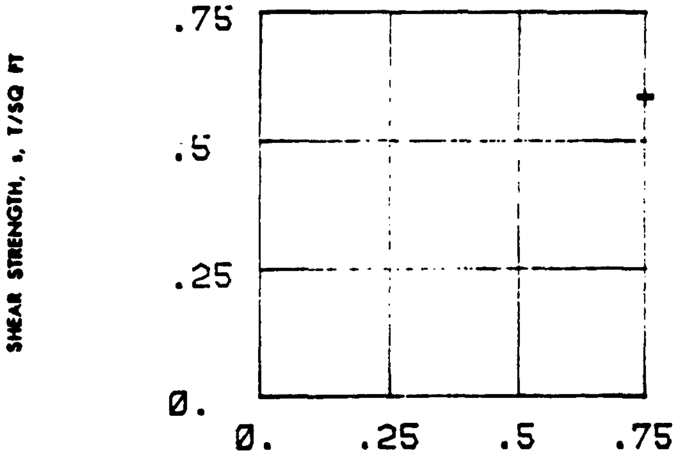
AREA MRD LAB NO: 86/216

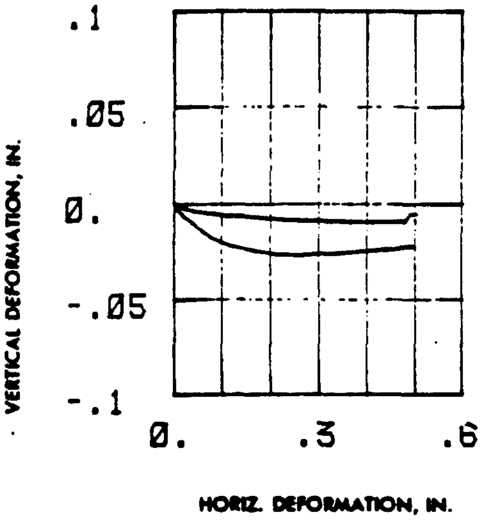
BORING NO. 84-77 SAMPLE NO. Sacks 3 & 4

DEPTH / EL 14-18 DATE

DIRECT SHEAR TEST REPORT PLATE B-43







NORMAL STRESS, σ, T/SQ FT

SHEAR STRENGTH PARAMETERS

φ' = ____________

TAN φ' = ____________

c' = ____________ T/SQ FT

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

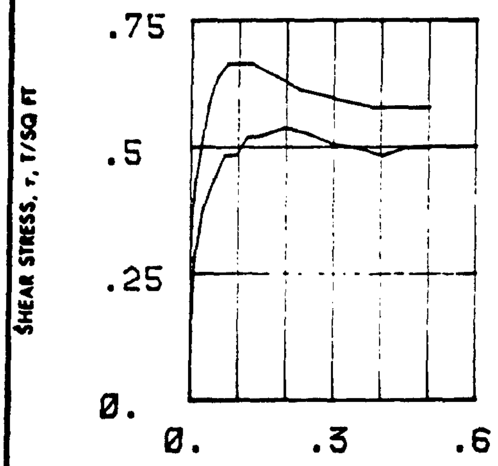
TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	4. %	12.3 %	%	%
	VOID RATIO	e_o	1.45	.82		
	SATURATION	S_o	7.5 %	41. %	%	%
	DRY DENSITY, LB/CU FT	γ_d	68.9	92.7		
VOID RATIO AFTER CONSOLIDATION		e_c	1.45	.82		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	25.7 %	23.1 %	%	%
	VOID RATIO	e_f	1.30	.70		
	SATURATION	S_f	50. %	80. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.59	.585		
ACTUAL TIME TO FAILURE, MIN		t_f	900	1320		
RATE OF STRAIN, IN./MIN		X .0001	3.77	5.64		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.565	.576		

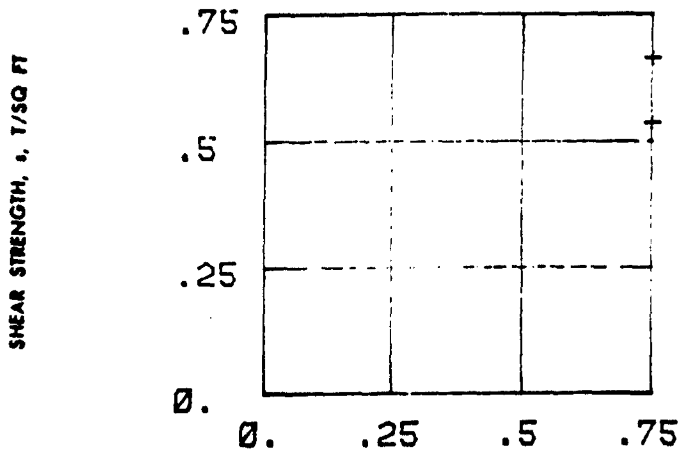
TYPE OF SPECIMEN Remolded		3. IN. SQUARE	.998 IN. THICK
CLASSIFICATION Clayey sand, SC			
LL 17	PL 19	PI	G_s 2.7 Assumed

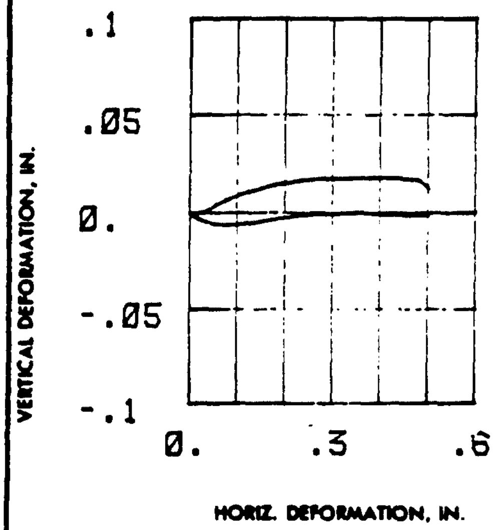
REMARKS ____________

PROJECT ROCHESTER; NCS-IA-86-65-ED-GH	
AREA MRD LAB NO: 86/216	
BORING NO. 84-78	SAMPLE NO. sacks 1 & 2
DEPTH EL 2-8	DATE

DIRECT SHEAR TEST REPORT PLATE B-44







SHEAR STRENGTH PARAMETERS

φ' = ____________

TAN φ' = ____________

c' = ____________ T/SQ FT

☐ CONTROLLED STRESS

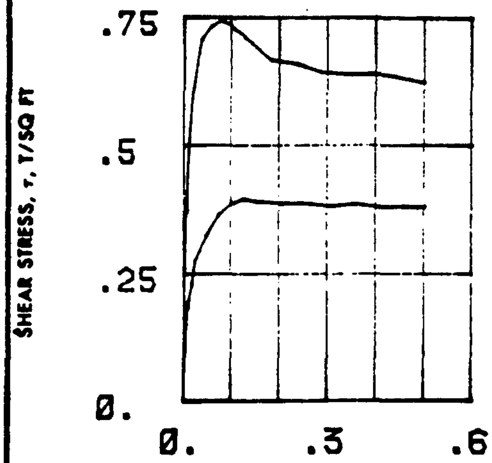
☒ CONTROLLED STRAIN

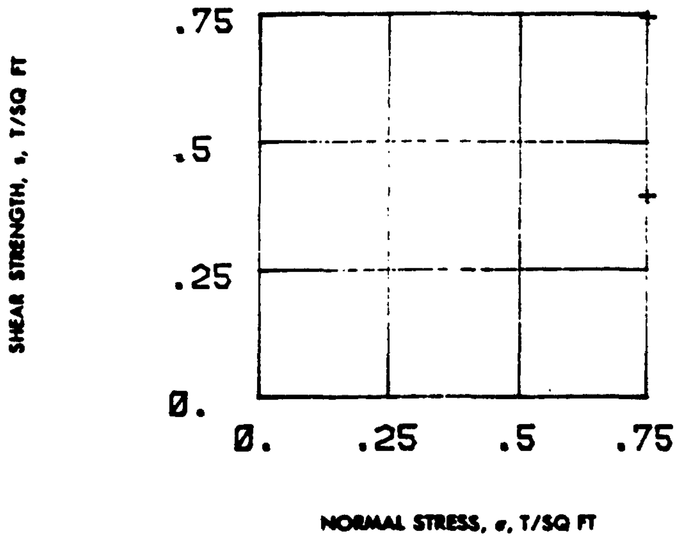
TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	.43 %	8. %	%	%
	VOID RATIO	e_o	.72	.51		
	SATURATION	S_o	1.6 %	42. %	%	%
	DRY DENSITY, LB/CU FT	γ_d	98.1	111.4		
VOID RATIO AFTER CONSOLIDATION		e_c	.72	.51		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	18.9 %	15.7 %	%	%
	VOID RATIO	e_f	.71	.54		
	SATURATION	S_f	71. %	78. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.538	.666		
ACTUAL TIME TO FAILURE, MIN		t_f	420	500		
RATE OF STRAIN, IN./MIN		X .0001	4.6	5.37		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.481	.577		

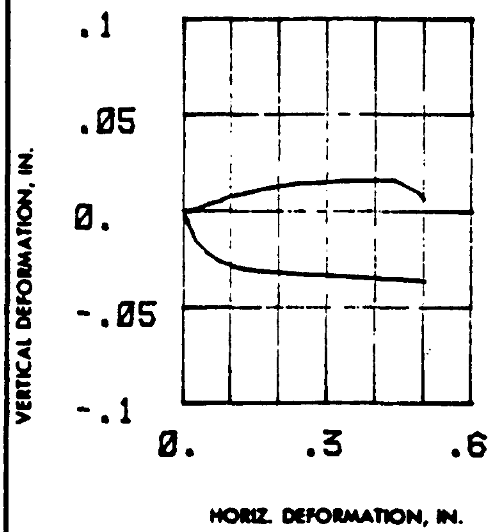
TYPE OF SPECIMEN REMOLDED		5. IN. SQUARE		1. IN. THICK
CLASSIFICATION Sand, SP				
LL	PL	PI		G_s 2.7 Assumed

REMARKS

PROJECT	ROCHESTER; NCS-IA-[illegible]
AREA	MRD LAB NO: 86/216
BORING NO. 84-78	SAMPLE NO. sacks 7 & 8
DEPTH EL 14-20	DATE
DIRECT SHEAR TEST REPORT	PLATE B-45







SHEAR STRENGTH PARAMETERS

φ′ = ____________

TAN φ′ = ____________

c′ = ____________ T/SQ FT

☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

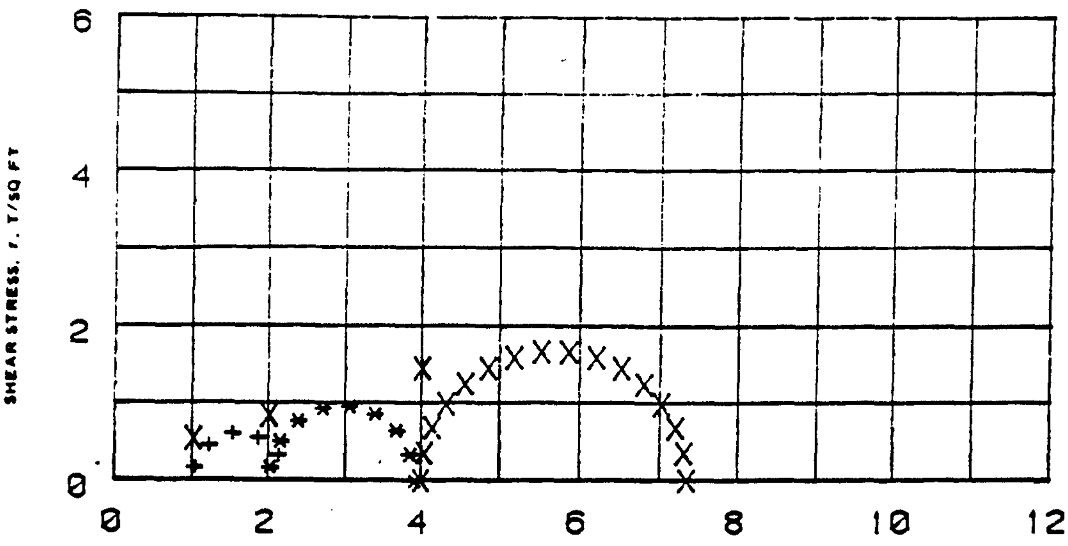
TEST NO.			1	2		
INITIAL	WATER CONTENT	w_o	1.4 %	9.5 %	%	%
	VOID RATIO	e_o	1.	.33		
	SATURATION	S_o	3.9 %	78. %	%	%
	DRY DENSITY, LB/CU FT	γ_d	84.	126.5		
VOID RATIO AFTER CONSOLIDATION		e_c	1.	.33		
TIME FOR 50 PERCENT CONSOLIDATION, MIN		t_{50}				
FINAL	WATER CONTENT	w_f	18.6 %	13.8 %	%	%
	VOID RATIO	e_f	.95	.35		
	SATURATION	S_f	53. %	100. %	%	%
NORMAL STRESS, T/SQ FT		σ	.75	.75		
MAXIMUM SHEAR STRESS, T/SQ FT		τ_{max}	.396	.744		
ACTUAL TIME TO FAILURE, MIN		t_f	300	240		
RATE OF STRAIN, IN./MIN		X .0001	4.14	3.27		
ULTIMATE SHEAR STRESS, T/SQ FT		τ_{ult}	.378	.624		

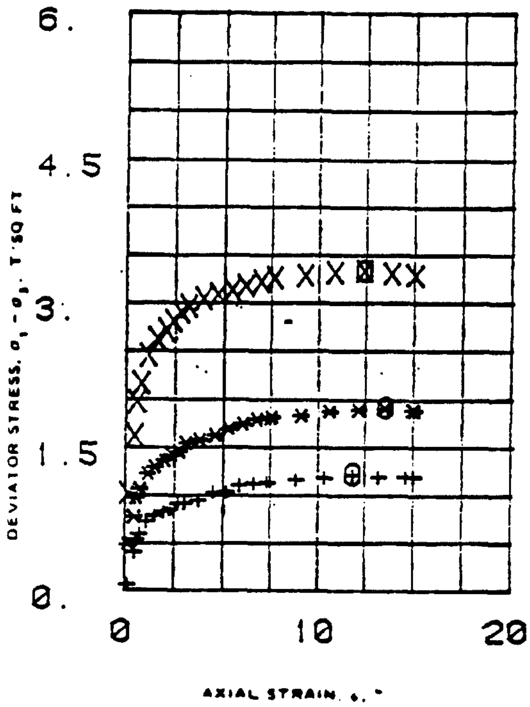
TYPE OF SPECIMEN	REMOLDED	3. IN. SQUARE	1. IN. THICK
CLASSIFICATION	Clayey sand, SC		
LL 11	PL 10	PI	G_s 2.7 Assumed

REMARKS ____________

PROJECT	ROCHESTER, MN; NCS-IR-86-05-ED-GH		
AREA	HRD LAB NO: 86/216		
BORING NO.	84-08M	SAMPLE NO.	sacks 1 & 2
DEPTH EL	6-15	DATE	

DIRECT SHEAR TEST REPORT PLATE B-46





			1	2	3
SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	42.7	42.4	41.8
	DRY DENSITY LB/CU FT	γd_o	74.9	75.8	75.9
	SATURATION, %	S_o	96.	97.	98.
	VOID RATIO	e_o	1.15	1.13	1.12
BEFORE SHEAR	WATER CONTENT, %	w_c	37.5	35.2	31.
	DRY DENSITY LB/CU FT	γd_c	78.5	84.4	91.7
	SATURATION, %	S_c	92.	100.	100.
	VOID RATIO	e_c	1.05	.91	.76
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.38	3.38	3.38
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.22	1.92	3.34
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	980	1080	980
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.2	1.89	3.29
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4
INITIAL HEIGHT, IN.		H_o	3.	3.	3.01

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS: Sandy clay, CH, possibly contains some organic.

LL 56 | PL 25 | PI 31 | Gs 2.58 | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST R

REMARKS: Dark brown. Calcareous.
Torvane=.63 TSF.

PROJECT: ROCHESTER; NCS-IA-88-85-ED-GH

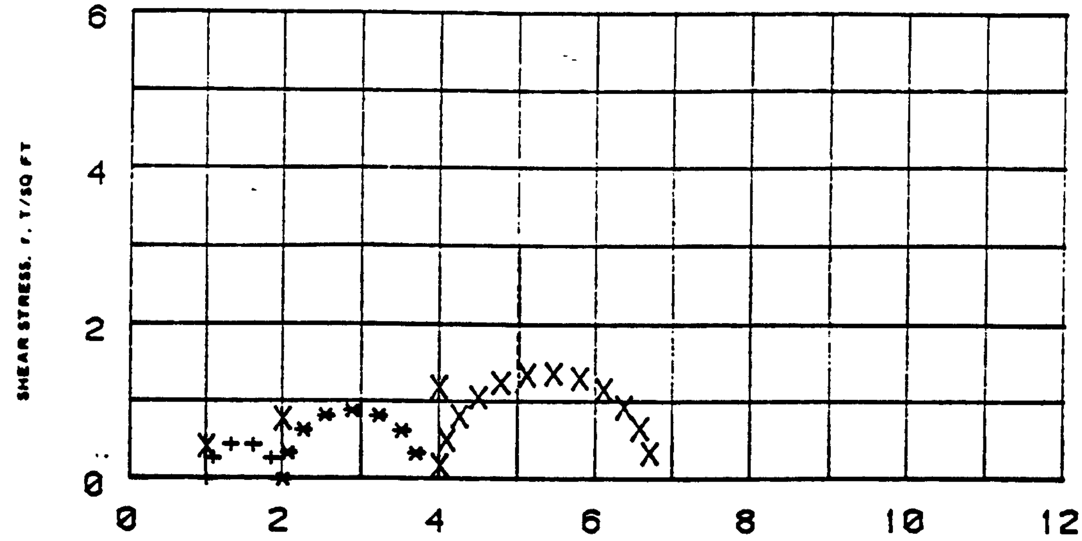
BORING NO. 84-73 | SAMPLE NO. 1

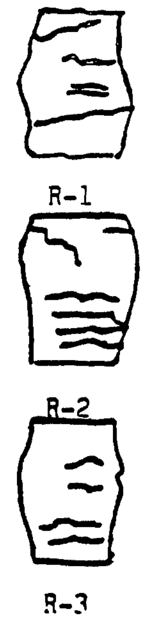
DEPTH/ELEV 11-13

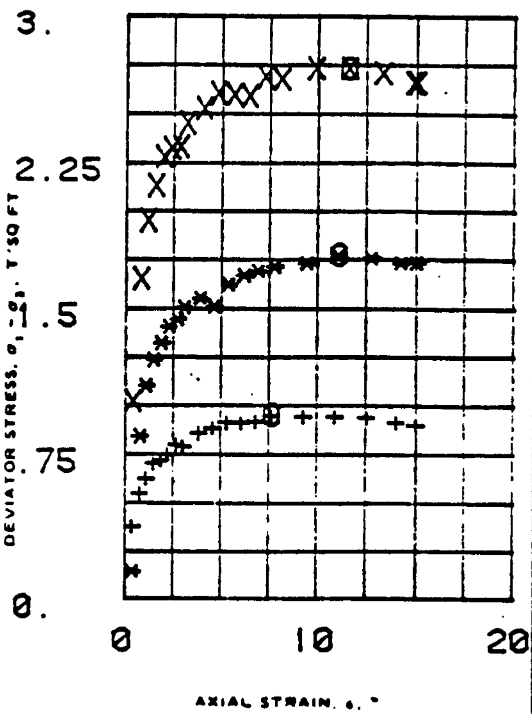
LABORATORY 86/218 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)







			1	2	3
SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	61.5	62.5	62.3
	DRY DENSITY LB/CU FT	γd_o	6Ø.9	61.1	61.6
	SATURATION, %	S_o	97.	1ØØ.	1ØØ.
	VOID RATIO	e_o	1.59	1.59	1.57
BEFORE SHEAR	WATER CONTENT, %	w_c	51.8	45.1	38.2
	DRY DENSITY, LB/CU FT	γd_c	68.2	7Ø.8	77.9
	SATURATION, %	S_c	94.	92.	94.
	VOID RATIO	e_c	1.39	1.24	1.Ø3
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.8	4.8	4.8
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.	2.	4.
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{max}$		.951	1.78	2.74
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	48Ø	6ØØ	6ØØ
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ult}$		.9Ø8	1.74	2.68
INITIAL DIAMETER, IN.		D_o	1.42	1.43	1.41
INITIAL HEIGHT, IN.		H_o	2.95	2.98	2.91

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH, possibly contains organic material.

LL 61 | PL 26 | PI 35 | Gs 2.53 | TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST $\bar{R}$

REMARKS Dark brown, calcareous.
Torvane=.20 TSF

PROJECT ROCHESTER, MN;NCS-IA-88-85-ED-GH

BORING NO 84-78 | SAMPLE NO. 1

DEPTH ELEV 1Ø.Ø-12.Ø

LABORATORY 88/218 | DATE

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
1 ———	11-13	Sandy clay, possibly contains some organic material.(84-73)		56	25	31
1 – – –	10-12	Fat Clay, CH, possibly contains organics (84-73)		61	26	35

Project ROCHESTER; NCS-IA-86-65-ED-GH

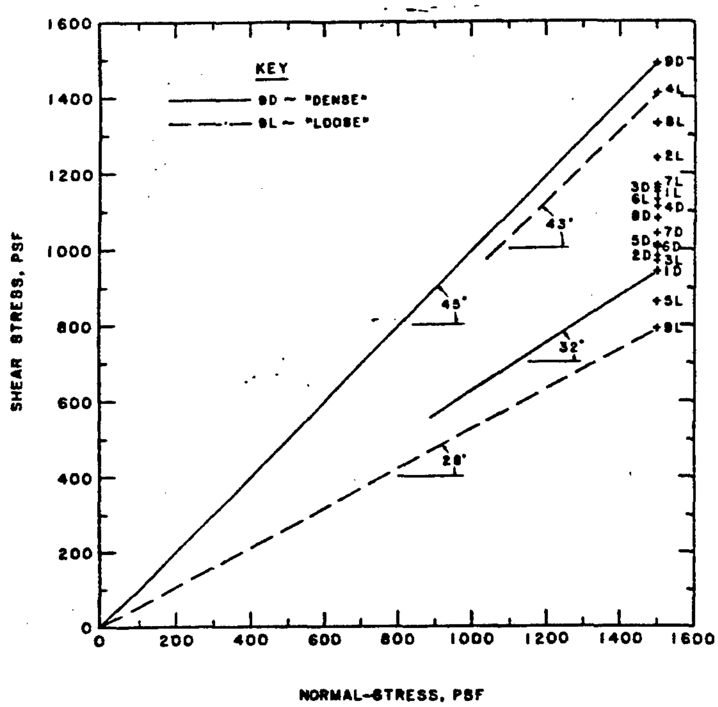
Area MRD LAB NO. 88/216

Boring No. 84-73

Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087



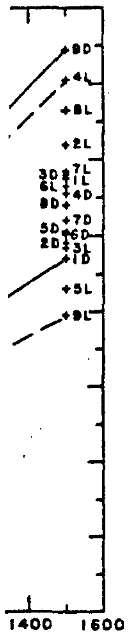
SHEAR STRESS VERSUS NORMAL STRESS

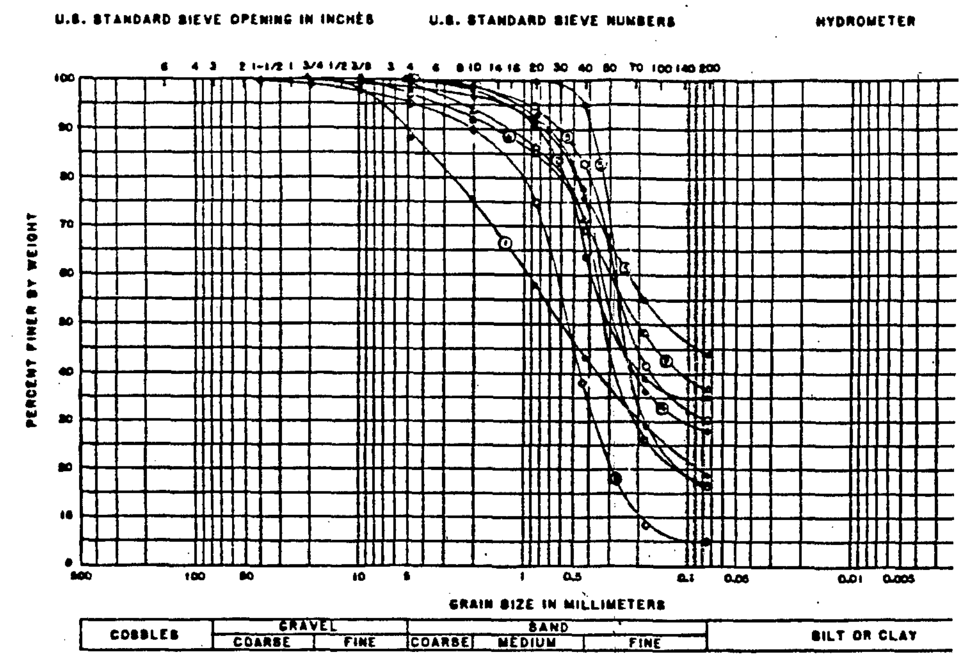
SAMPLE NO.			83-55M-1/2		83-57M-1/2		84-68M-1/2		84-68M-3/4		84-77M-1/2		84-77M-3/4		84-78M-1/2	
TEST NO.			1D *	1L *	2D *	2L *	3L	3D	4D *	4L *	5L	5D	6D *	6L *	7D *	7L *
INITIAL	WATER CONTENT	w_o	7.5%	3.3%	10.7%	2.5%	2.0%	11.8%	15.6%	7.9%	0.88%	5.8%	7.1%	3.0%	12.3%	4.0%
INITIAL	VOID RATIO	e_o	0.41	1.11	0.38	1.08	1.02	0.47	0.45	1.66	1.09	0.58	0.46	1.29	0.74	1.34
INITIAL	SATURATION	S_o	49.0%	8.0%	77.0%	6.4%	5.4%	68.0%	94.0%	13.0%	2.4%	28.0%	42.0%	6.2%	4.3%	7.8%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	119.1	79.8	122.5	81.0	83.5	114.4	116.6	63.4	80.7	108.8	115.5	73.6	92.7	68.9
VOID RATIO AFTER CONSOLIDATION		e_c	0.41	1.11	0.38	1.08	1.02	0.47	0.45	1.07	1.09	0.58	0.46	1.29	0.74	1.34
TIME FOR 50% CONSOLIDATION, MIN																
FINAL	WATER CONTENT	w_f	14.4%	15.7%	14.1%	15.6%	20.4%	17.8%	15.8%	18.8%	18.5%	16.1%	16.0%	16.7%	23.1%	25.7%
FINAL	VOID RATIO	e_f	0.34	1.12	0.29	1.08	0.96	0.48	0.38	1.09	1.03	0.55	0.40	1.29	0.65	1.32
FINAL	SATURATION	S_f	100%	38%	100%	39%	57%	100%	100%	46%	49%	78%	100%	35%	92%	50%
NORMAL STRESS, T/SQ FT		σ	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
DESIGN SHEAR STRESS, T/SQ FT		τ	0.470	0.576	0.490	0.619	0.487	0.578	0.555	0.704	0.430	0.505	0.503	0.564	0.520	0.582
ACTUAL TIME TO FAILURE, MIN		t_f	1268	1260	1020	240	420	120	1440	420	1020	360	660	360	900	1320
RATE OF STRAIN, IN/MIN X .0001			3.95	3.94	3.93	3.60	4.62	3.82	3.28	4.47	4.44	4.20	4.17	5.17	3.77	3.64
ULTIMATE SHEER STRESS, T/SQ FT		τ_{ULT}	0.828	0.578	0.541	0.572	0.464	0.506	0.703	0.551	0.433	0.483	0.429	0.432	0.566	0.573
LIQUID LIMIT		L.L.	N.P.		27		27		N.P.		N.P.		N.P.		36	
PLASTIC LIMIT		P.L.	N.P.		13		13		N.P.		N.P.		N.P.		19	

DIRECT SHEAR TEST RESULTS SUMMARY

NOTES:

1. SAMPLE NUMBERS REFER TO SACKS OF MATERIAL COMBINED FROM 5 IN. DIA. TUBE SAMPLES.
2. ASTERISK (*) INDICATES WHERE "LOOSE" SAMPLE HAS HIGHER SHEAR STRENGTH THAN "DENSE" SAMPLE.
3. SAMPLE DESIGNATION L = "LOOSE" D = "DENSE"
4. INDIVIDUAL TEST RESULTS AND STRESS STRAIN CURVES PRESENTED ON PLATES B-36 THROUGH B-46.





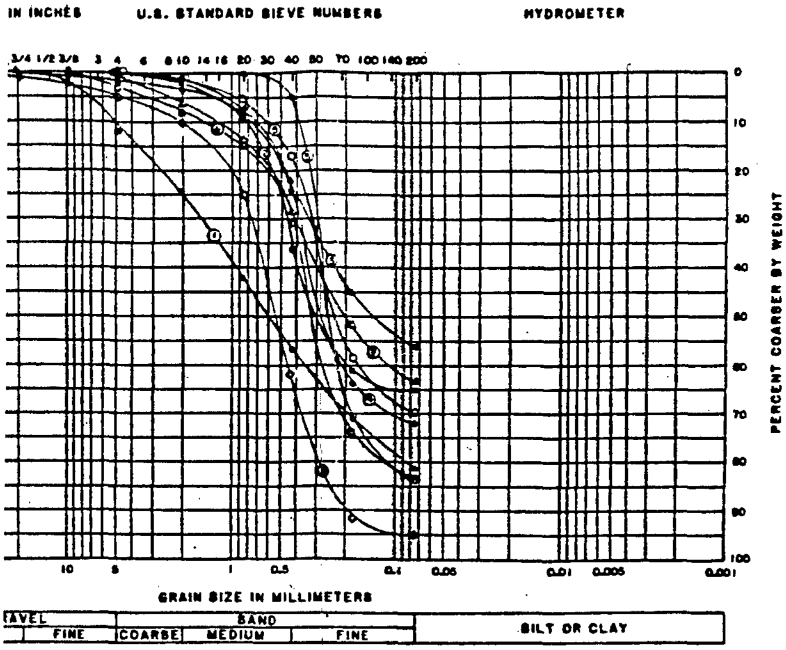
DIRECT SHEAR TEST SAMPLE
GRAIN – SIZE DISTRIBUTION CURVES

M-1/2	84-68M-3/4		84-77M-1/2		84-77M-3/4		84-78M-1/2		84-78M-7/8		84-80M-1/2	
3D	4D*	4L*	5L	5D	6D*	6L*	7D*	7L*	8D*	8L*	9L	9D
11.9%	15.6%	7.9%	0.98%	5.8%	7.1%	3.0%	12.3%	4.0%	8.0%	0.43%	1.4%	9.5%
0.47	0.45	1.66	1.09	0.88	0.46	1.29	0.74	1.34	0.51	0.72	0.95	0.29
68.0%	94.0%	13.0%	2.4%	28.0%	42.0%	6.2%	4.3%	7.8%	42.0%	1.6%	4.0%	86.0%
114.4	116.6	63.4	90.7	108.5	118.5	73.6	92.7	68.9	111.4	98.1	84.0	126.5
0.47	0.45	1.07	1.09	0.88	0.46	1.29	0.74	1.34	0.51	0.72	0.95	0.29
17.8%	15.8%	18.8%	18.5%	16.1%	16.0%	16.7%	23.1%	25.7%	15.7%	18.9%	18.6%	13.8%
0.48	0.38	1.09	1.03	0.55	0.40	1.29	0.65	1.32	0.51	0.73	0.89	0.31
100%	100%	46%	49%	79%	100%	35%	92%	50%	84%	70%	55%	100%
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.579	0.555	0.704	0.430	0.505	0.503	0.564	0.520	0.582	0.538	0.666	0.396	0.744
120	1440	420	1020	360	660	360	900	1320	420	300	300	240
3.82	3.28	4.47	4.44	4.20	4.17	5.17	3.77	3.64	4.60	3.37	4.14	3.27
0.506	0.703	0.551	0.433	0.483	0.429	0.432	0.566	0.573	0.481	0.577	0.378	0.624
27	N.P.		N.P.		N.P.		36		-		21	
3	N.P.		N.P.		N.P.		19		-		10	

DIRECT SHEAR TEST RESULTS
SUMMARY

SYMBOL
SUBMITTED BY: A.B.
DRAWN BY: M.S.
CHECKED BY:
SUBMITTED BY:

2



DIRECT SHEAR TEST SAMPLE
GRAIN – SIZE DISTRIBUTION CURVES

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

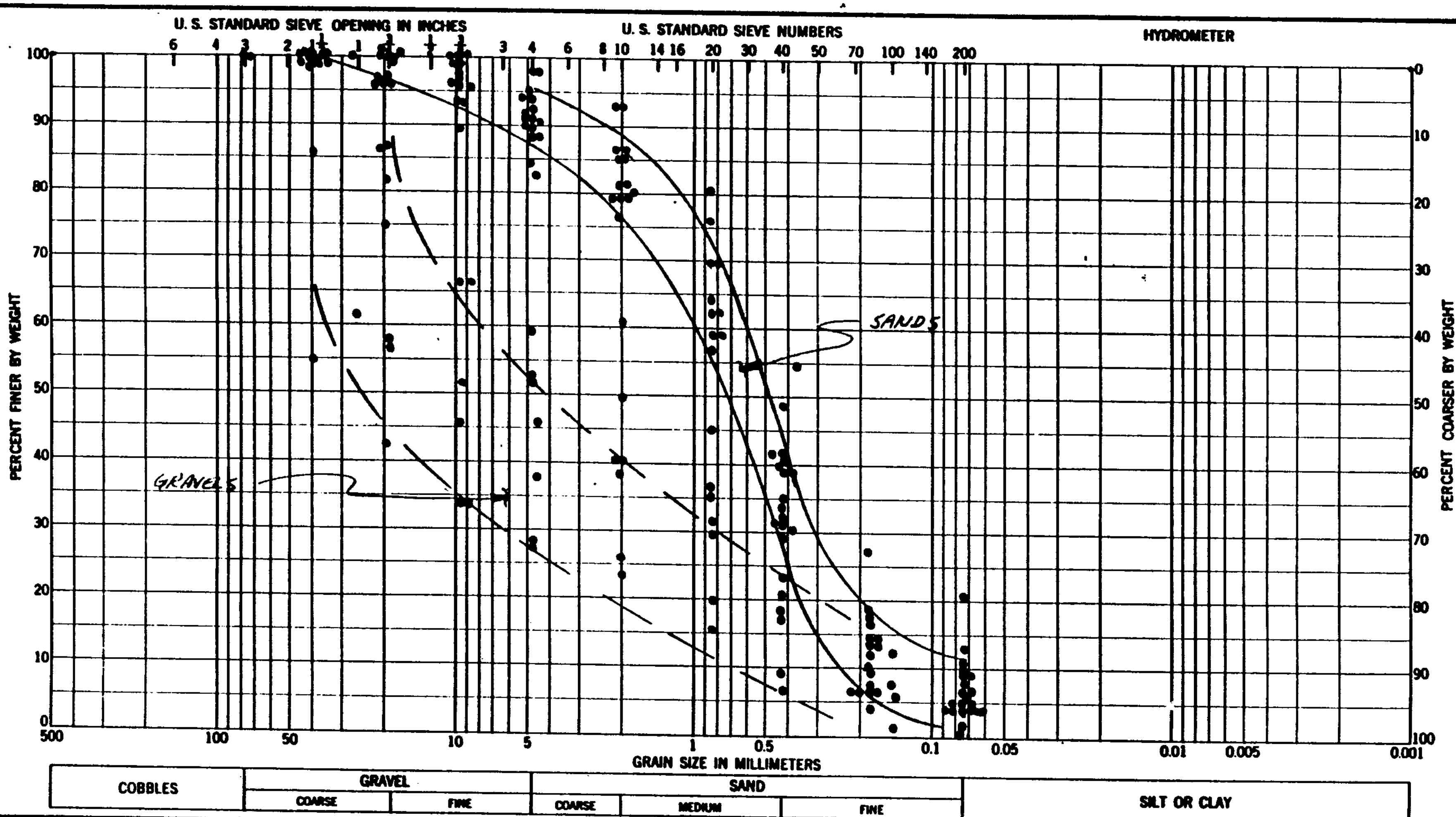
DESIGNED BY: R.B.F.
DRAWN BY: M.S.R.
CHECKED BY:
SUBMITTED BY:

DESIGN MEMORANDUM NO. PHASE , FEATURE
APPENDIX – B
FLOOD CONTROL – MISSISSIPPI RIVER
S. FORK ZUMBRO RIVER – ROCHESTER, MINNESOTA
ROCHESTER
DIRECT SHEAR TEST RESULTS

APPROVED BY:
DATE: JANUARY 1967
SCALE: AS SHOWN
FILE NO.
DRAWING NUMBER
SHEET OF

3

PLATE B-50



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI

Project FLOOD CONTROL
ROCHESTER, MN

Area S.FORK ZUMBRO R. - REACH 1B

Boring No. LOWER ALLUVIUM

Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087

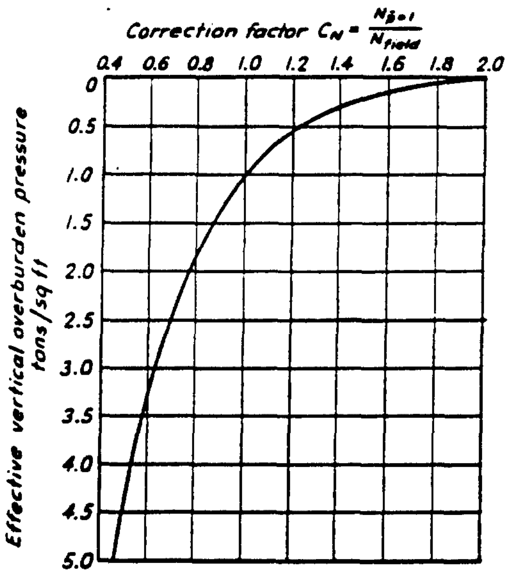


Figure a: Chart for correction of N-values in sand for influence of overburden pressure.

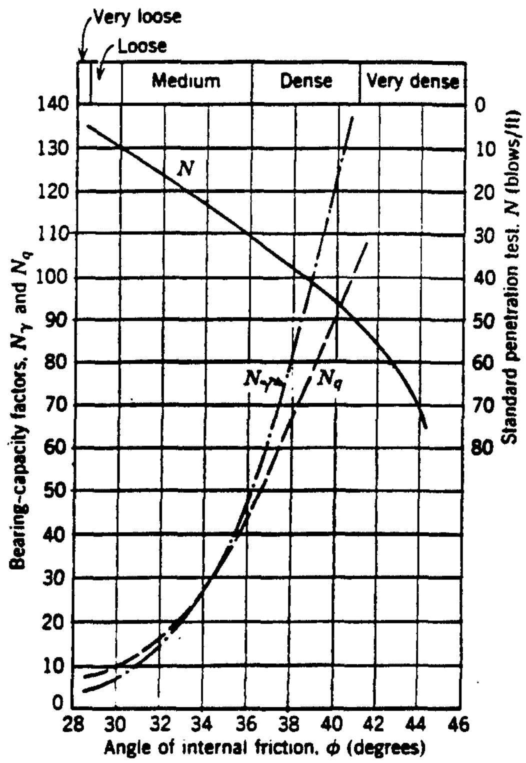


Figure b: Correlation between Standard Penetration Resistance, N, and Angle of internal resistance, ϕ, in granul- deposits.

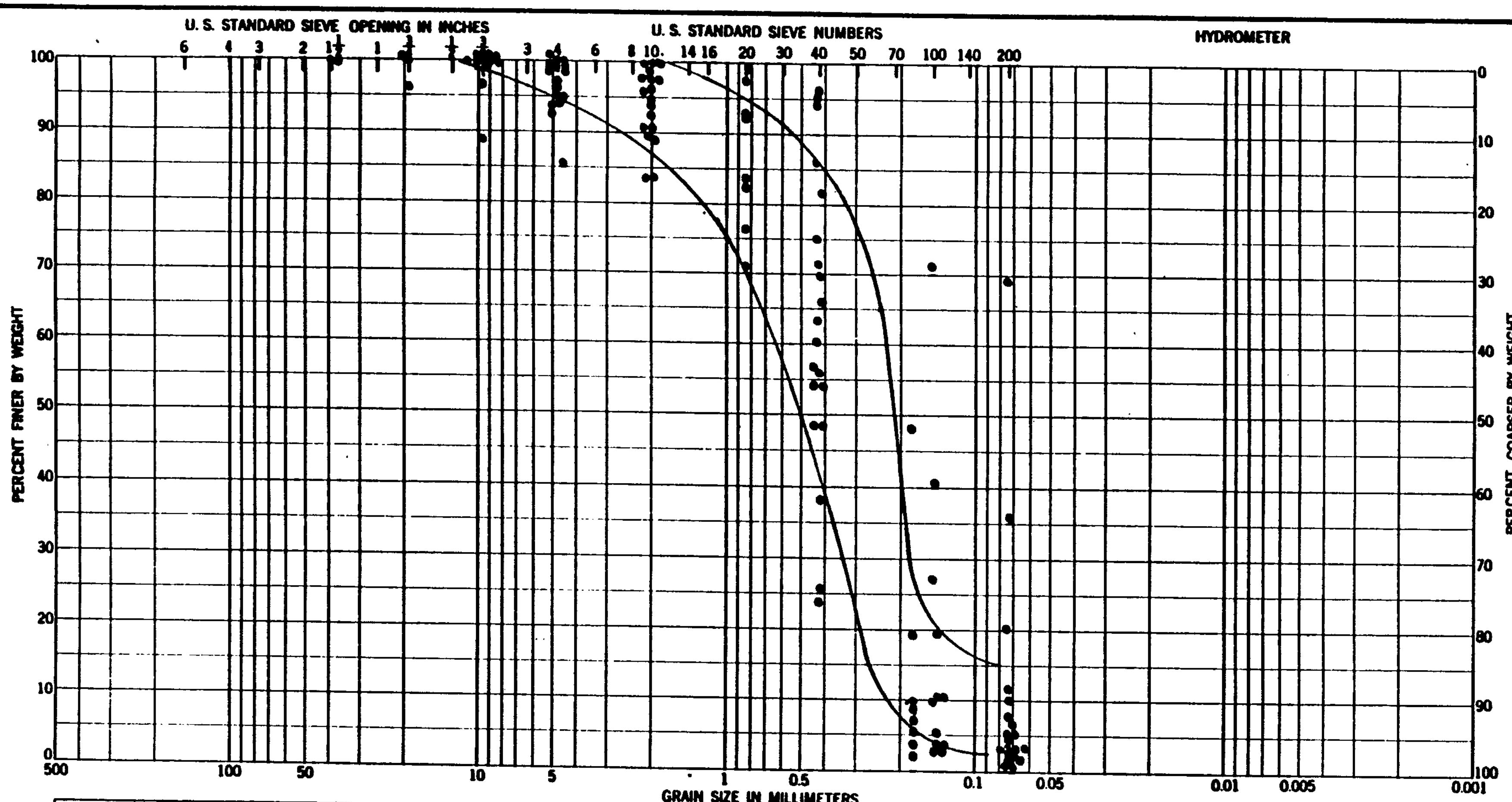
Figures a & b taken from Foundation Engineering, Peck, Ralph B., Hanson, Walter E., & Thornburn, Thomas H., John Wiley & Sons, N.Y., 1953 & 1974.

DESIGN MEMORANDUM NO. 2 PHASE IB . - FEATU
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

N VERSUS ϕ CORRELATION

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-52



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI

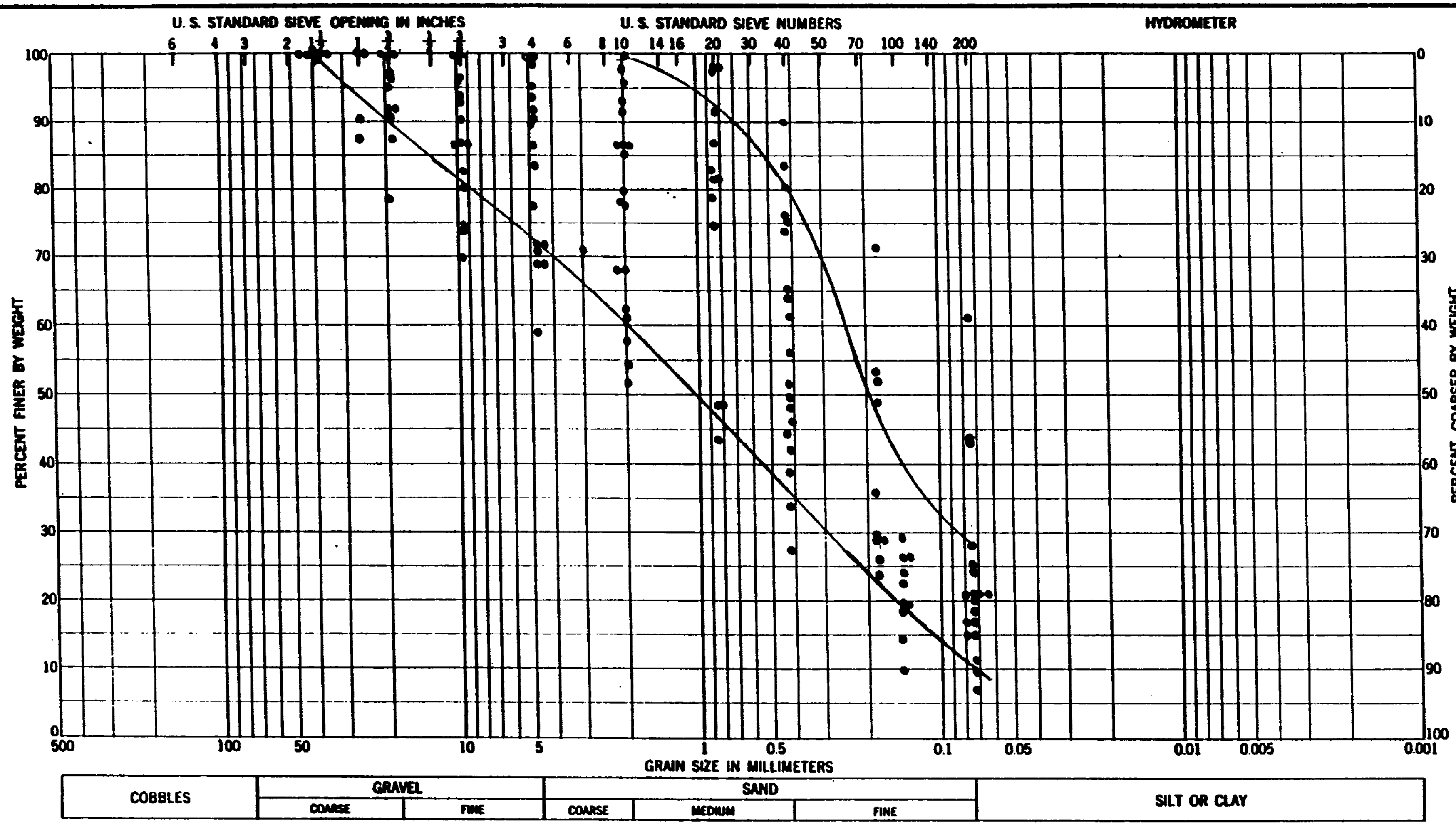
Project FLOOD CONTROL
ROCHESTER, MN
Area S.FORK ZUMBRO R. - REACH 1B
Boring No. UPPER ALLUVIUM
Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-53

63



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI

Project FLOOD CONTROL

ROCHESTER, MN

Area S.FORK ZUMBRO R.- REACH 1B

Boring No. EXISTING FILL

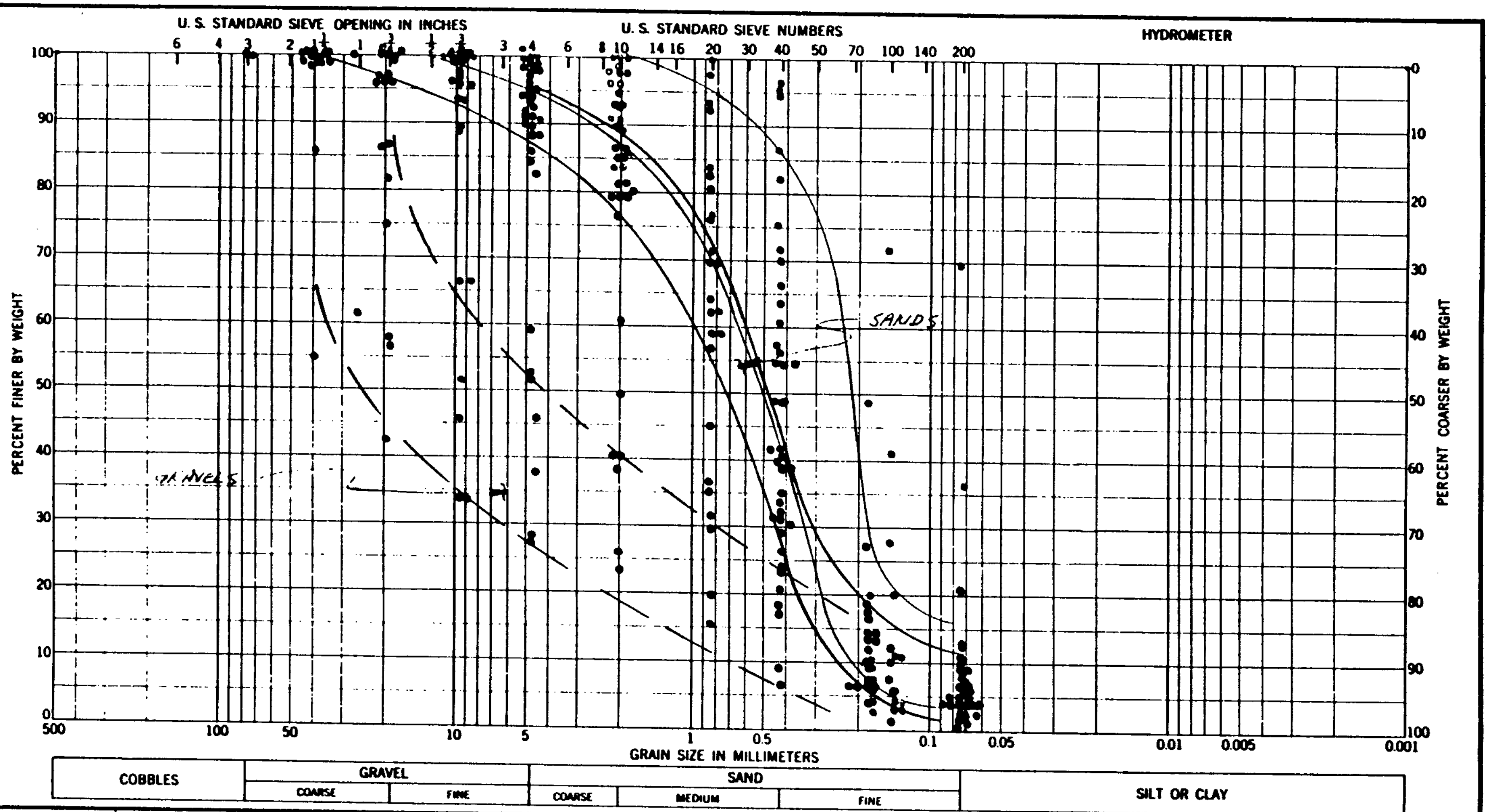
Date

54

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE B-54

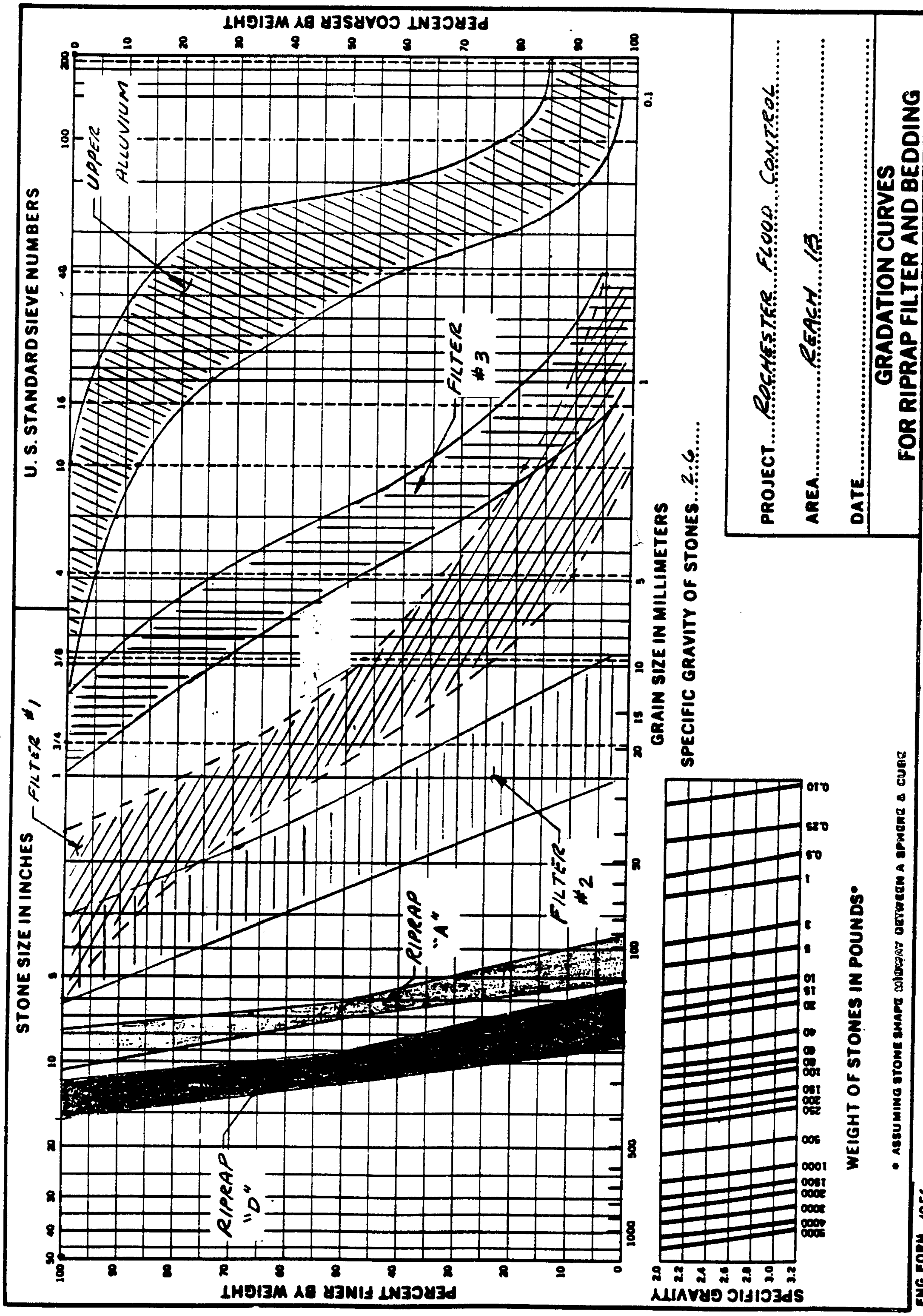


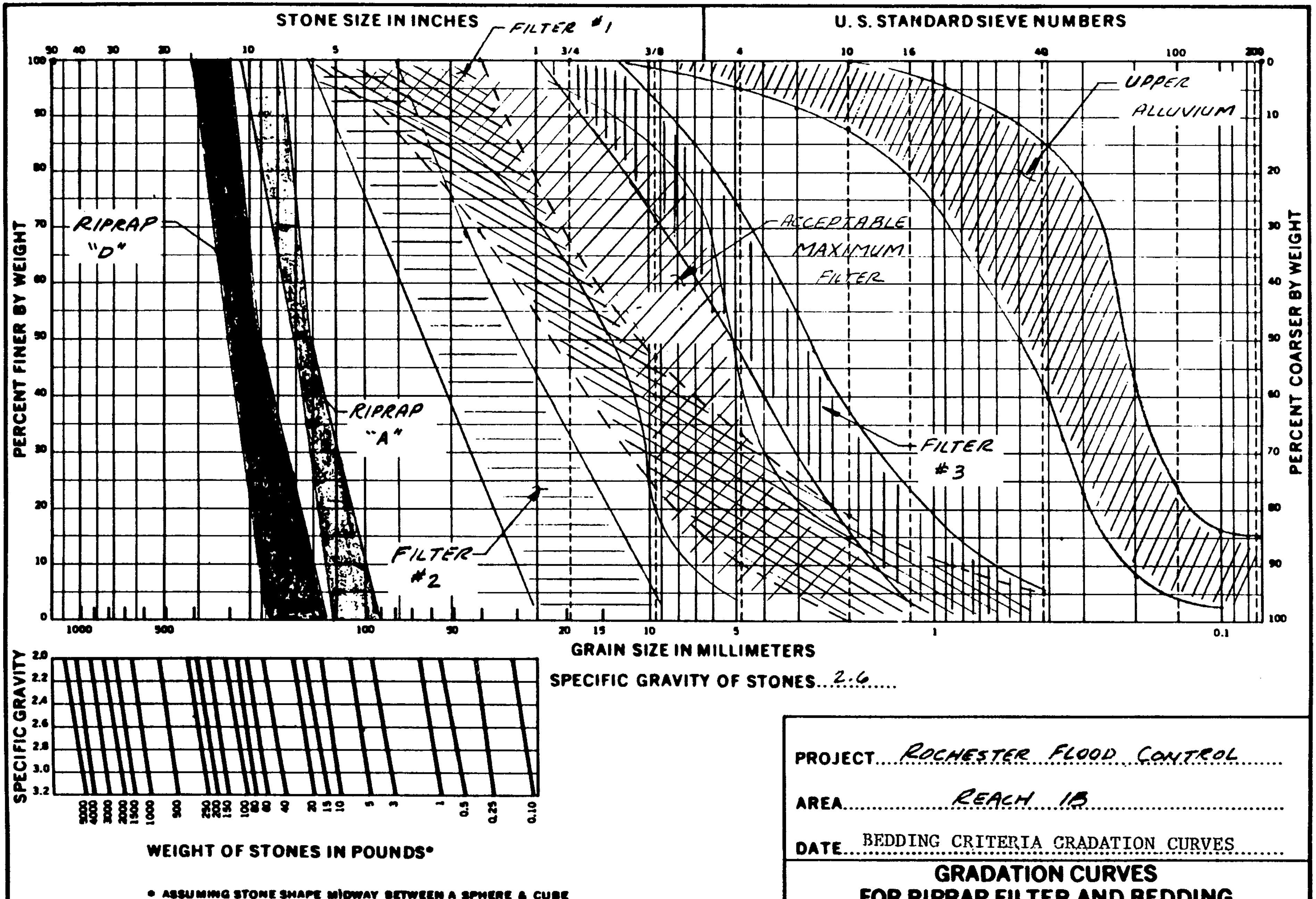
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI

Project FLOOD CONTROL
ROCHESTER, MN
Area S.FORK ZUMBRO R. - REACH 1B
Boring No. LOWER ALLUVIUM
AND UPPER ALLUVIUM
Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087


GRADATION CURVES
FOR RIPRAP FILTER AND BEDDING
PROJECT ROCHESTER FLOOD CONTROL
AREA REACH 1B
DATE
U. S. STANDARD SIEVE NUMBERS
STONE SIZE IN INCHES
GRAIN SIZE IN MILLIMETERS
SPECIFIC GRAVITY OF STONES 2.6
PERCENT COARSER BY WEIGHT
PERCENT FINER BY WEIGHT
WEIGHT OF STONES IN POUNDS*
SPECIFIC GRAVITY
UPPER ALLUVIUM
FILTER #1
FILTER #2
FILTER #3
RIPRAP "A"
RIPRAP "D"
ENG FORM 4056



SPECIFIC GRAVITY OF STONES 2.6

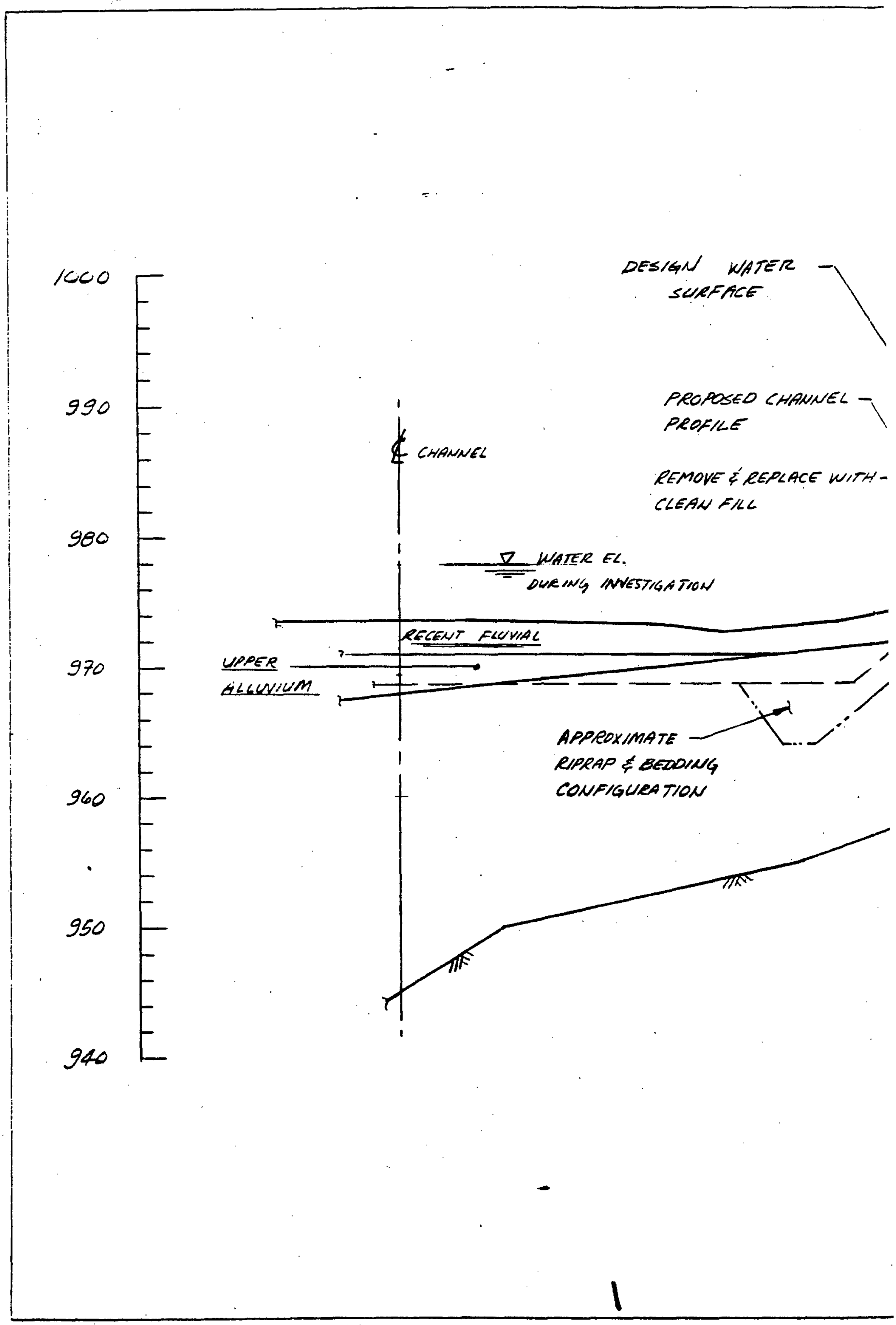
PROJECT ROCHESTER FLOOD CONTROL

AREA REACH 1B

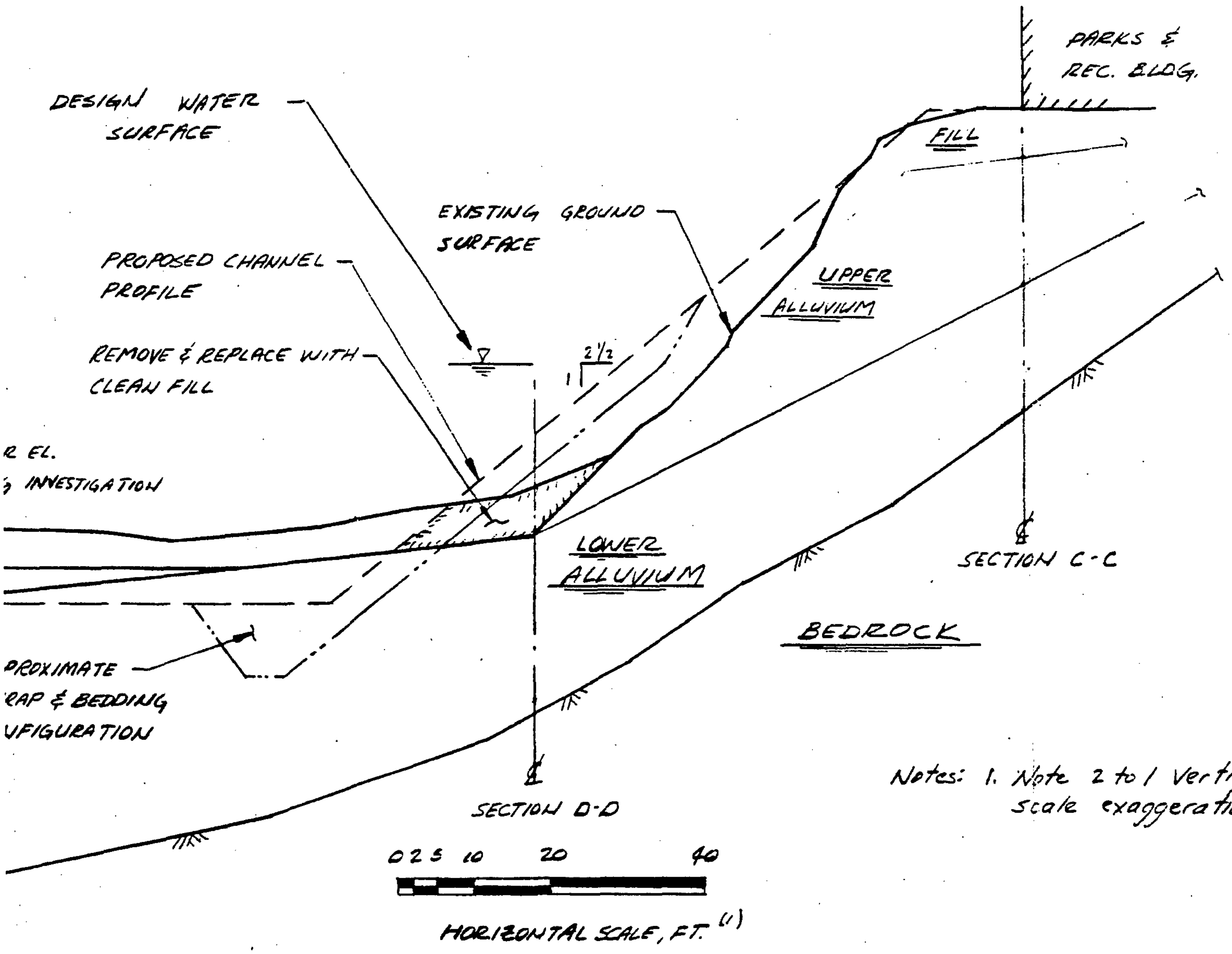
DATE BEDDING CRITERIA GRADATION CURVES

GRADATION CURVES FOR RIPRAP FILTER AND BEDDING

ENG FORM 4056 APR 67



1000
990
980
970
960
950
940
DESIGN WATER SURFACE
PROPOSED CHANNEL PROFILE
℄ CHANNEL
REMOVE & REPLACE WITH CLEAN FILL
WATER EL. DURING INVESTIGATION
RECENT FLUVIAL
UPPER ALLUVIUM
APPROXIMATE RIPRAP & BEDDING CONFIGURATION



Notes: 1. Note 2 to 1 Vertical scale exaggeration

CHANNEL X-SECTION

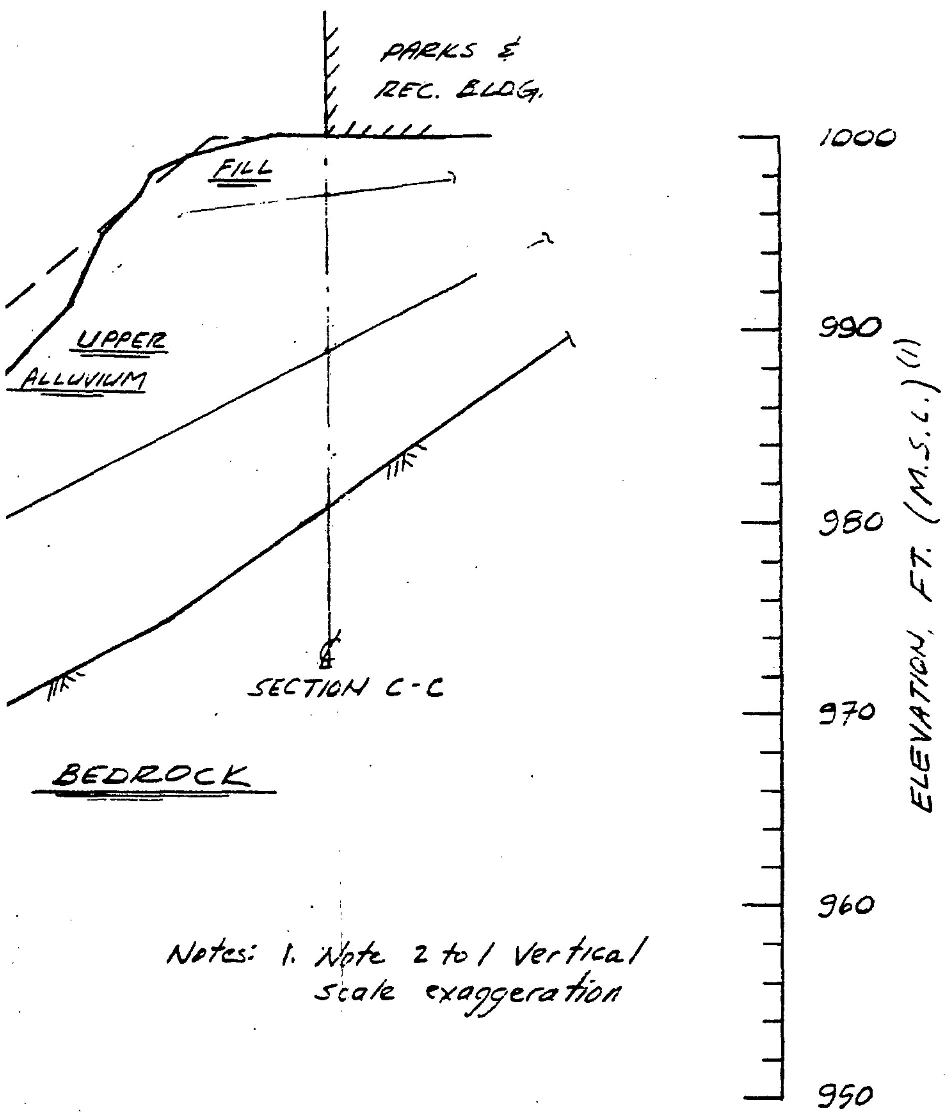
STA. 180+40

RIGHT BANK

DESIGN MEMO

CROSS S

St. Paul Di
File No.



Notes: 1. Note 2 to 1 Vertical scale exaggeration

DESIGN MEMORANDUM NO. 2 PHASE 1B . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CROSS SECTION - STA. 180+40, RIGHT BANK

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-58

COMPUTER DATA FILE

```
6
ROCHESTER, MN - FLOOD CONTROL - REACH 18
S. FORK ZUMBRO RIVER
STATION 180+40 RIGHT BANK -FILE ZR180RB
SEARCH EL = 973
END-OF-CONSTRUCTION - WATER EL. 974

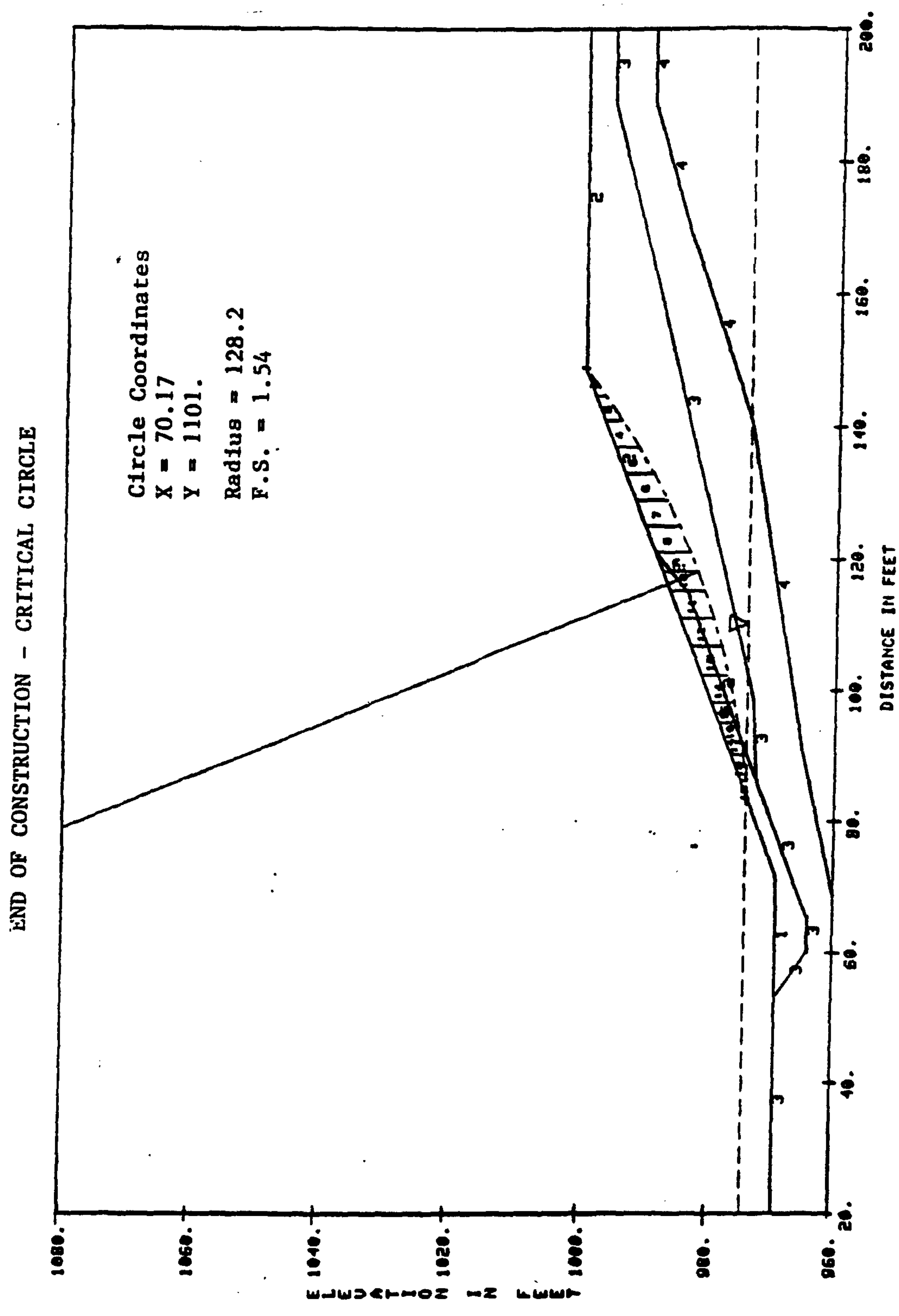
  973       80    1070     10.0    1.0
   19       15       0.0
0 0 0 0 0 0 0 0
-5000     969      53     969      3
   53     969      60     964      3
   60     964      65     964      3
   65     964      86     972.5    3
   86     972.5    98     973      3
   98     973     189     996      3
  189     996    5000     996      3
   86     972.5   115     984      2
  115     984     121     989      2
  121     989     148.5  1000      2
  148.5  1000    5000    1000      2
   53     969      71     969      1
   71     969     121     989      1
-5000     944       0     944      4
    0     944      90     965      4
   90     965     141     974      4
  141     974     169     984      4
  169     984     189     990      4
  189     990    5000     990      4
    1     125     140       0     36      0      0
    2     115     120       0     30      0      0
    3     135     130       0     36      0      0
    4     145     145   10000     45      0      0
    2
-5000     974
 5000     974
    0
```

DESIGN MEMORANDUM NO. 2 PHASE IB . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

COMPUTER DATA FILE
STABILITY ANALYSIS RESULTS - STA. 180+40
END-OF-CONSTRUCTION CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-69



DESIGN MEMORANDUM NO. 2 PHASE I/B , - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CRITICAL CIRCLE
STABILITY ANALYSIS RESULTS - STA. 180+40
END-OF-CONSTRUCTION CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-61

END OF CONST CRITICAL ELEVATION
TABULATION OF SLICE DATA

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIREC TION	DEVEL C-FORCE	DIREC TION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	.36	148.7	.01	0.	0.	0.	37.78	20.58	.01	.01	0.	10.9	0.	0.
2	3.75	146.6	.41	0.	0.	0.	36.62	20.58	.08	.36	10.9	21.8	0.	.12
3	3.75	142.9	.92	0.	0.	0.	34.56	20.58	.18	.81	21.8	21.8	.12	.34
4	4.	139.	1.45	0.	0.	0.	32.48	20.58	.27	1.28	21.8	21.8	.34	.64
5	4.	135.	1.84	0.	0.	0.	30.39	20.58	.35	1.63	21.8	21.8	.64	.96
6	4.	131.	2.14	0.	0.	0.	28.33	20.58	.42	1.91	21.8	21.8	.96	1.26
7	4.	127.	2.35	0.	0.	0.	26.32	20.58	.48	2.13	21.8	21.8	1.26	1.51
8	4.	123.	2.49	0.	0.	0.	24.34	20.58	.52	2.27	21.8	21.8	1.51	1.68
9	3.	119.5	1.93	0.	0.	0.	22.64	20.58	.55	1.78	21.8	21.8	1.68	1.75
10	3.	116.5	1.97	0.	0.	0.	21.19	20.58	.57	1.83	21.8	21.8	1.75	1.77
11	4.25	112.9	2.76	0.	0.	0.	19.46	20.58	.58	2.61	21.8	21.8	1.77	1.72
12	4.25	108.6	2.62	0.	0.	0.	17.46	20.58	.56	2.52	21.8	21.8	1.72	1.56
13	4.25	104.4	2.41	0.	0.	0.	15.48	20.58	.53	2.35	21.8	21.8	1.56	1.32
14	4.25	100.1	2.11	0.	0.	0.	13.52	20.58	.48	2.1	21.8	21.8	1.32	1.02
15	3.02	96.49	1.28	0.	0.	0.	11.85	20.58	.42	1.29	21.8	21.8	1.02	.8
16	3.02	93.48	1.07	0.	0.	0.	10.48	20.58	.36	1.09	21.8	21.8	.8	.58
17	1.97	90.98	.56	0.	0.	0.	9.35	25.29	.3	.6	21.8	21.8	.58	.38
18	4.	88.	.78	0.	0.	0.	8.	25.29	.21	.84	21.8	21.8	.38	.08
19	3.52	84.24	.24	.05	90.	0.	6.3	25.29	.06	.21	21.8	21.8	.08	0.

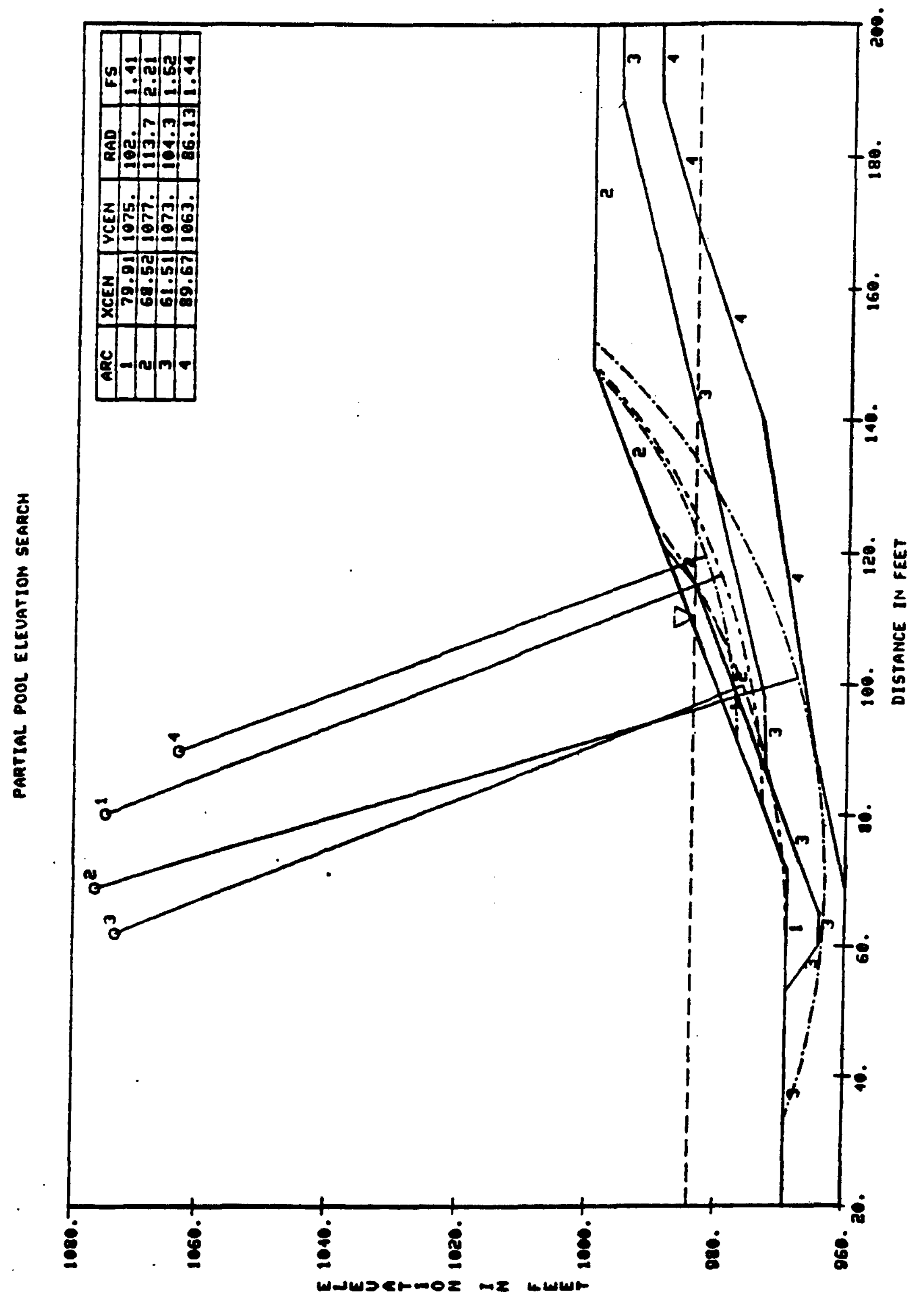
ALL FORCES IN KIPS
ALL ANGLES MEASURED FROM POSITIVE X-AXIS

DESIGN MEMORANDUM NO. 2 PHASE IB , - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

SLICE DATA SUMMARY
STABILITY ANALYSIS RESULTS - STA. 180+40
END-OF-CONSTRUCTION CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-63



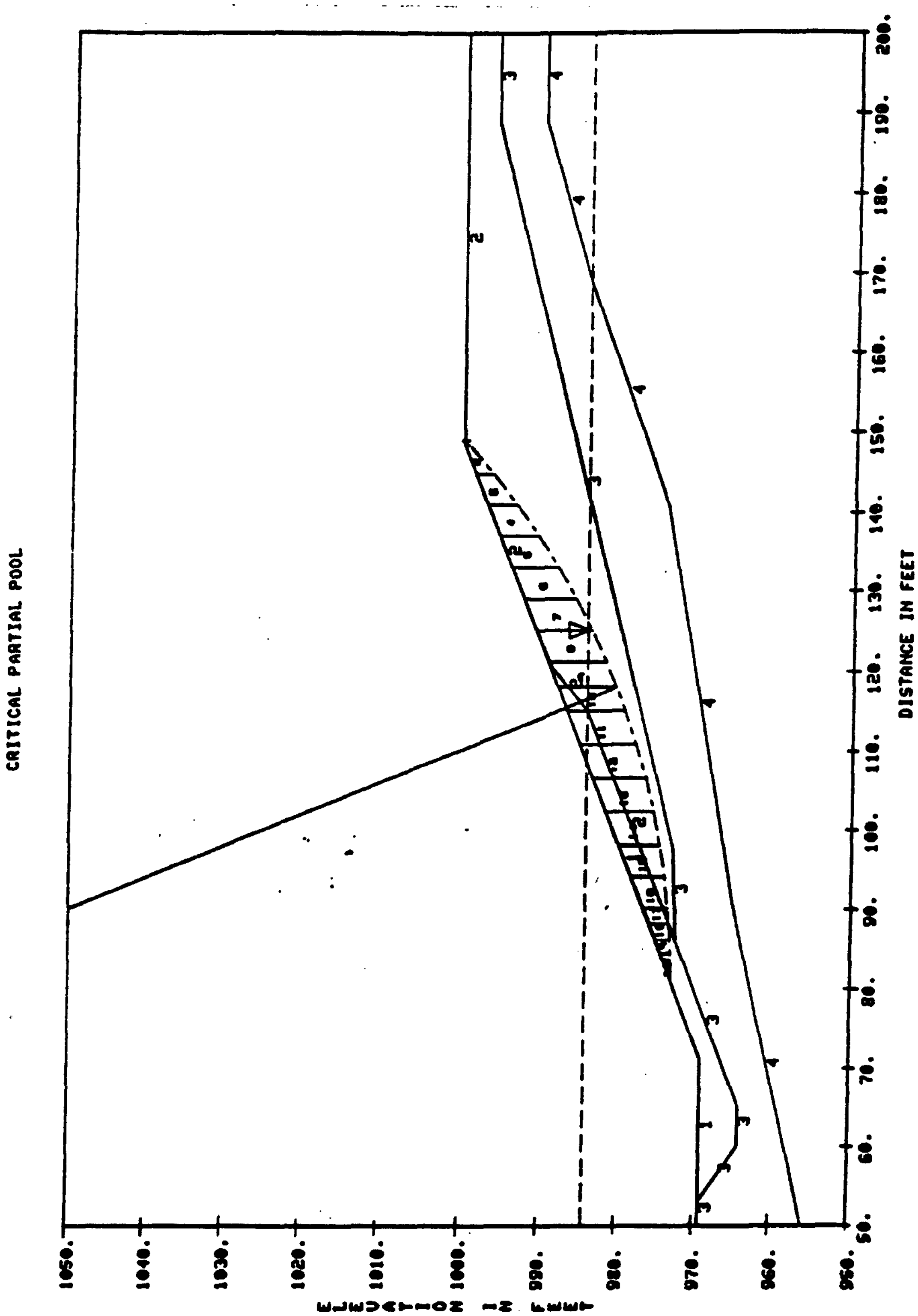
ARC	XCEN	YCEN	RAD	FS
1	79.91	1075.	102.	1.41
2	68.52	1077.	113.7	2.21
3	61.51	1073.	104.3	1.52
4	89.67	1063.	86.13	1.44

DESIGN MEMORANDUM NO. PHASE , - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CIRCULAR SEARCH SUMMARY
STABILITY ANALYSIS RESULTS - STA. 180+40
PARTIAL POOL CASE

St. Paul District, U... Army Corps of Engineers
File No. January 1987
PLATE B-65



DESIGN MEMORANDUM NO. 2 PHASE IB, - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CRITICAL CIRCLE (ENLARGED SCALE)
STABILITY ANALYSIS RESULTS - STA. 180+40
PARTIAL POOL CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 19--,
PLATE B-67

CRITICAL PARTIAL POOL
TABULATION OF SLICE DATA

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIREC TION	DEVEL C-FORCE	DIREC TION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	.54	148.8	.02	0.	0.	0.	42.46	22.25	.02	.01	0.	10.9	0.	.01
2	3.75	146.6	.61	0.	0.	0.	40.85	22.25	.1	.52	10.9	21.8	.01	.2
3	3.75	142.9	1.29	0.	0.	0.	38.12	22.25	.23	1.12	21.8	21.8	.2	.55
4	4.	139.	2.	0.	0.	0.	35.4	22.25	.35	1.73	21.8	21.8	.55	1.01
5	4.	135.	2.5	0.	0.	0.	32.69	22.25	.46	2.19	21.8	21.8	1.01	1.48
6	4.	131.	2.89	0.	0.	0.	30.06	22.25	.55	2.56	21.8	21.8	1.48	1.88
7	4.	127.	3.16	0.	0.	0.	27.5	22.25	.63	2.84	21.8	21.8	1.88	2.18
8	4.	123.	3.36	.36	90.	0.	24.99	22.25	.62	2.73	21.8	21.8	2.18	2.33
9	3.	119.5	2.62	.56	90.	0.	22.84	22.25	.58	1.9	21.8	21.8	2.33	2.36
10	3.	116.5	2.68	.79	90.	0.	21.02	22.25	.55	1.76	21.8	21.8	2.36	2.31
11	4.25	112.9	3.82	1.47	90.	0.	18.86	22.25	.5	2.24	21.8	21.8	2.31	2.16
12	4.25	108.6	3.75	1.82	90.	0.	16.35	22.25	.42	1.87	21.8	21.8	2.16	1.94
13	4.25	104.4	3.47	1.69	90.	0.	13.88	22.25	.4	1.77	21.8	21.8	1.94	1.64
14	4.26	100.1	3.09	1.49	90.	0.	11.43	22.25	.38	1.63	21.8	21.8	1.64	1.28
15	4.	96.	2.47	1.18	90.	0.	9.08	22.25	.33	1.35	21.8	21.8	1.28	.92
16	4.	92.	1.97	.92	90.	0.	6.81	22.25	.28	1.13	21.8	21.8	.92	.57
17	1.91	89.05	.74	.33	90.	0.	5.14	22.25	.23	.45	21.8	21.8	.57	.42
18	2.09	87.05	.63	.28	90.	0.	4.01	27.24	.2	.41	21.8	21.8	.42	.22
19	2.49	84.75	.48	.22	90.	0.	2.72	27.24	.13	.32	21.8	21.8	.22	.06
20	2.49	82.26	.17	.07	90.	0.	1.32	27.24	.05	.11	21.8	21.8	.06	0.

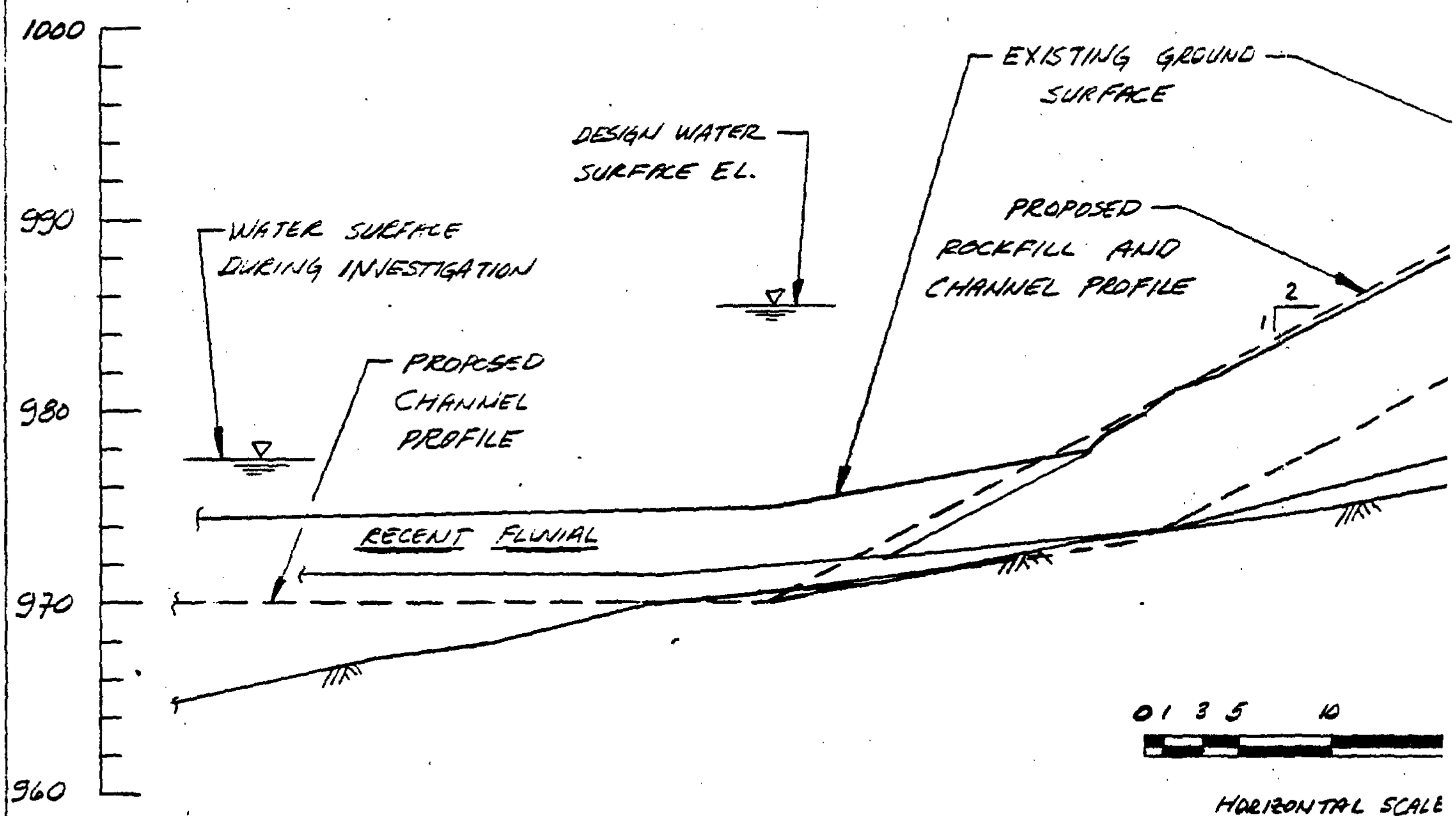
ALL FORCES IN KIPS
ALL ANGLES MEASURED FROM POSITIVE X-AXIS

DESIGN MEMORANDUM NO. 2 PHASE I B , - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

SLICE DATA SUMMARY
STABILITY ANALYSIS RESULTS - STA. 180+40
PARTIAL POOL CASE

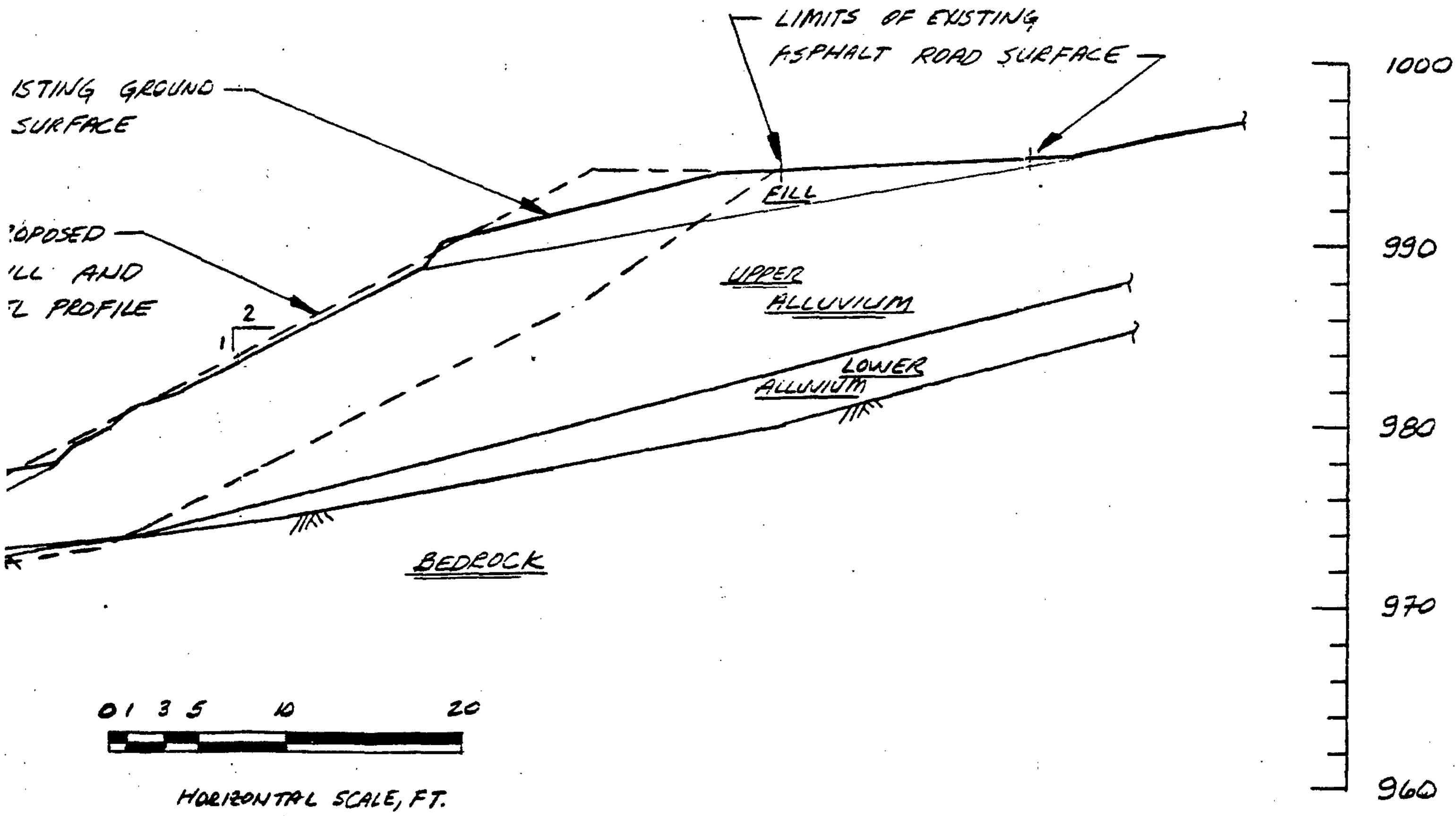
St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-69



CHANNEL X-SEC

STA. 186+00 to 1

RIGHT BANK



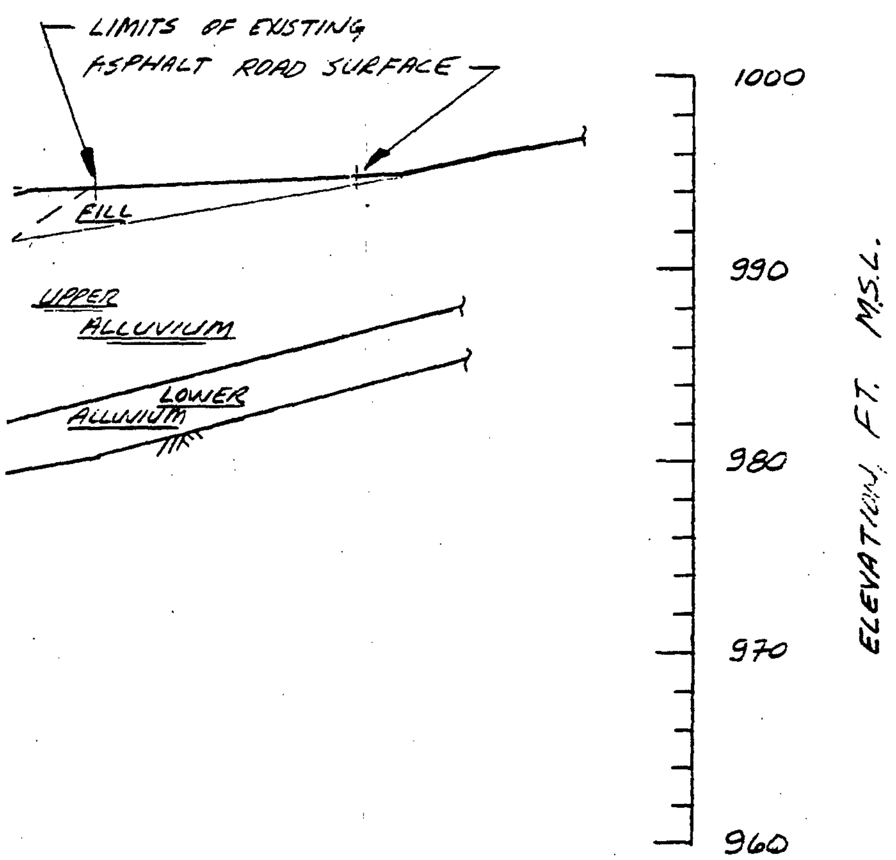
CHANNEL X-SECTION
STA. 186+00 to 188+00
RIGHT BANK

DESIGN MEMORANDUM NO. 2

FLOOD CONT
ROCHESTER, MI

CROSS SECTION - STA. 18

St. Paul District, U.S. Arm
File No.



DESIGN MEMORANDUM NO. 2 PHASE 1B. - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CROSS SECTION - STA. 186+75, RIGHT BANK

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-70

COMPUTER DATA FILE

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6
S. FORK ZUMBRO R. - FLOOD CONTROL
ROCHESTER, MN.
STATION 186+75, RIGHT BANK, ZR186RH
END OF CONSTRUCTION - POOL EL 974
ROCKFILL - 2H:1V SIDESLOPE

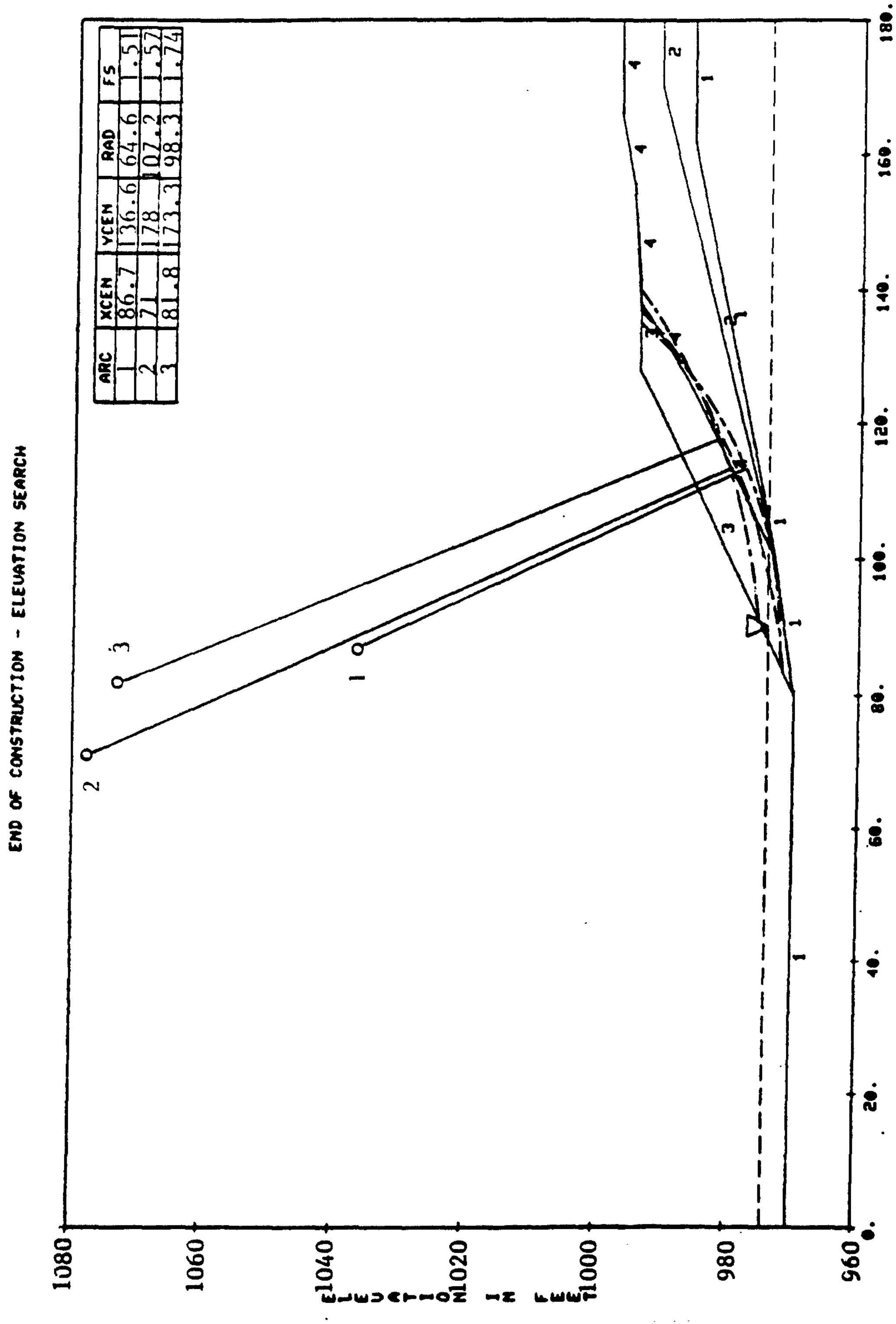
72.0  76   178    5   0.0
14 15      0.0
0 0 0 0 0 0 0 0
-5000     70      80      70     1
   80     70     100      73     1
  100     73     110      75     1
  110     75     162      86     1
  162     86    5000      86     1
   80     70     128      94     3
  128     94     138      94     3
  100     73     170      91     2
  170     91    5000      91     2
  100     73     127      87     4
  127     87     138      94     4
  138     94     155      95     4
  155     95     166      97     4
  166     97    5000      97     4
    1    160     160   10000    45     0     0
    2    135     138       0    38     0     0
    3    125     140       0    38     0     0
    4    110     120       0    30     0     0
    2
-5000     74
 5000     74
0
```

DESIGN MEMORANDUM NO. 2 PHASE IB, - FEATUR
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

COMPUTER DATA FILE
STABILITY ANALYSIS RESULTS - STA. 186+75
END-OF-CONSTRUCTION CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 198?
PLATE B-7?

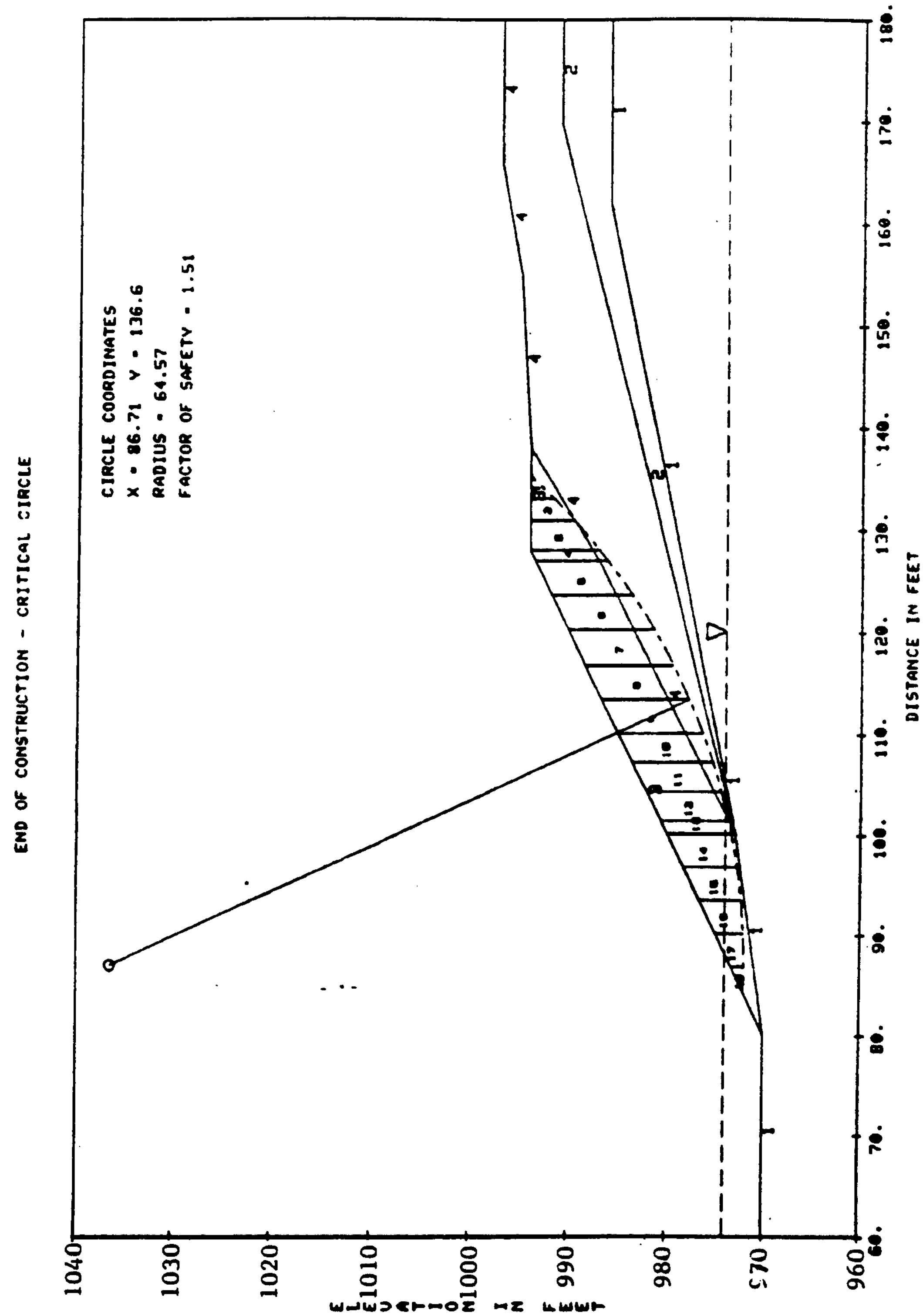


DESIGN MEMORANDUM NO. PHASE . - FEAT
APPENDIX B - GEO

FLOOD CONTROL
ROCHESTER, MINNESOTA

CIRCULAR SEARCH SUMMARY
STABILITY ANALYSIS RESULTS - STA. 1 75
END-OF-CONSTRUCTION CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-72

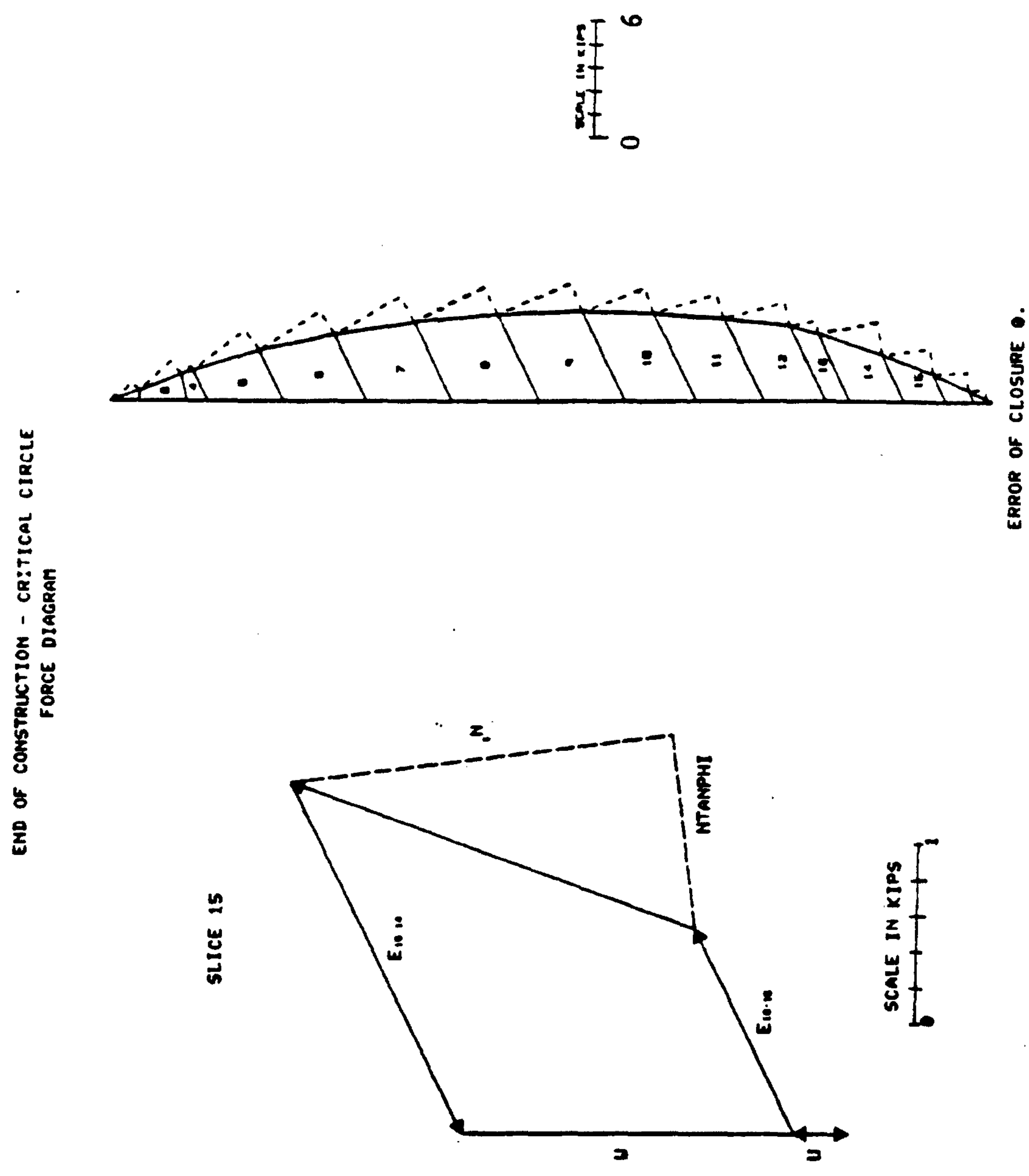


DESIGN MEMORANDUM NO. 2 PHASE 1B, - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CRITICAL CIRCLE
STABILITY ANALYSIS RESULTS - STA. 186+75
END-OF-CONSTRUCTION CASE

St. Paul District, U.S. Army Corps of Engineers
File No.
January 1987
PLATE B-73



DESIGN MEMORANDUM NO. PHASE . - FEATUR
APPENDIX B - GEOT

FLOOD CONTROL
ROCHESTER, MINNESOTA

TYPICAL SLICE FORCE DIAGRAM
STABILITY ANALYSIS RESULTS - STA. 1[illegible]5
END-OF-CONSTRUCTION CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-74

END OF CONSTRUCTION - CRITICAL CIRCLE
TABULATION OF SLICE DATA

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIREC TION	DEVEL C-FORCE	DIREC TION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	2.19	134.2	.33	0.	0.	0.	47.3	27.32	.1	.32	0.	0.	0.	.12
2	2.19	132.	.95	0.	0.	0.	44.51	27.32	.29	.89	0.	0.	.12	.42
3	2.88	129.4	2.09	0.	0.	0.	41.43	20.9	.47	1.82	0.	13.28	.42	1.13
4	1.	127.5	.89	0.	0.	0.	39.17	20.9	.39	.51	13.28	26.57	1.13	1.42
5	3.4	125.3	3.27	0.	0.	0.	36.7	20.9	.66	2.78	26.57	26.57	1.42	2.33
6	3.4	121.9	3.52	0.	0.	0.	33.02	20.9	.75	3.04	26.57	26.57	2.33	3.09
7	3.4	118.5	3.66	0.	0.	0.	29.49	20.9	.82	3.22	26.57	26.57	3.09	3.67
8	3.4	115.1	3.7	0.	0.	0.	26.08	20.9	.88	3.32	26.57	26.57	3.67	4.03
9	3.4	111.7	3.64	0.	0.	0.	22.77	20.9	.91	3.35	26.57	26.57	4.03	4.16
10	2.91	108.5	3.01	0.	0.	0.	19.76	20.9	.92	2.84	26.57	26.57	4.16	4.09
11	2.91	105.6	2.85	0.	0.	0.	17.05	20.9	.91	2.76	26.57	26.57	4.09	3.87
12	2.91	102.7	2.65	0.	0.	0.	14.37	20.9	.88	2.64	26.57	26.57	3.87	3.51
13	1.28	100.6	1.1	.04	90.	0.	12.46	27.32	.86	1.12	26.57	26.57	3.51	3.14
14	3.32	98.34	2.59	.2	90.	0.	10.37	27.32	.78	2.62	26.57	26.57	3.14	2.18
15	3.32	95.02	2.14	.3	90.	0.	7.39	27.32	.63	2.12	26.57	26.57	2.18	1.27
16	3.32	91.7	1.61	.37	90.	0.	4.43	27.32	.45	1.51	26.57	26.57	1.27	.54
17	3.32	88.37	1.	.41	90.	0.	1.47	27.32	.23	.77	26.57	26.57	.54	.12
18	2.61	85.41	.25	.11	90.	0.	-1.16	27.32	.07	.19	26.57	26.57	.12	0.

ALL FORCES IN KIPS
ALL ANGLES MEASURED FROM POSITIVE X-AXIS

DESIGN MEMORANDUM NO. 2 PHASE IB. - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

SLICE DATA SUMMARY
STABILITY ANALYSIS RESULTS - STA. 186+75
END-OF-CONSTRUCTION CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 198?
PLATE B-75

COMPUTER DATA FILE

```
6
S. FORK ZUMBRO R. - FLOOD CONTROL
ROCHESTER, MN.
STATION 186+75, RIGHT BANK, ZR186RE
PARTIAL POOL - EL = 981
ROCKFILL - 2H:1V SIDESLOPE

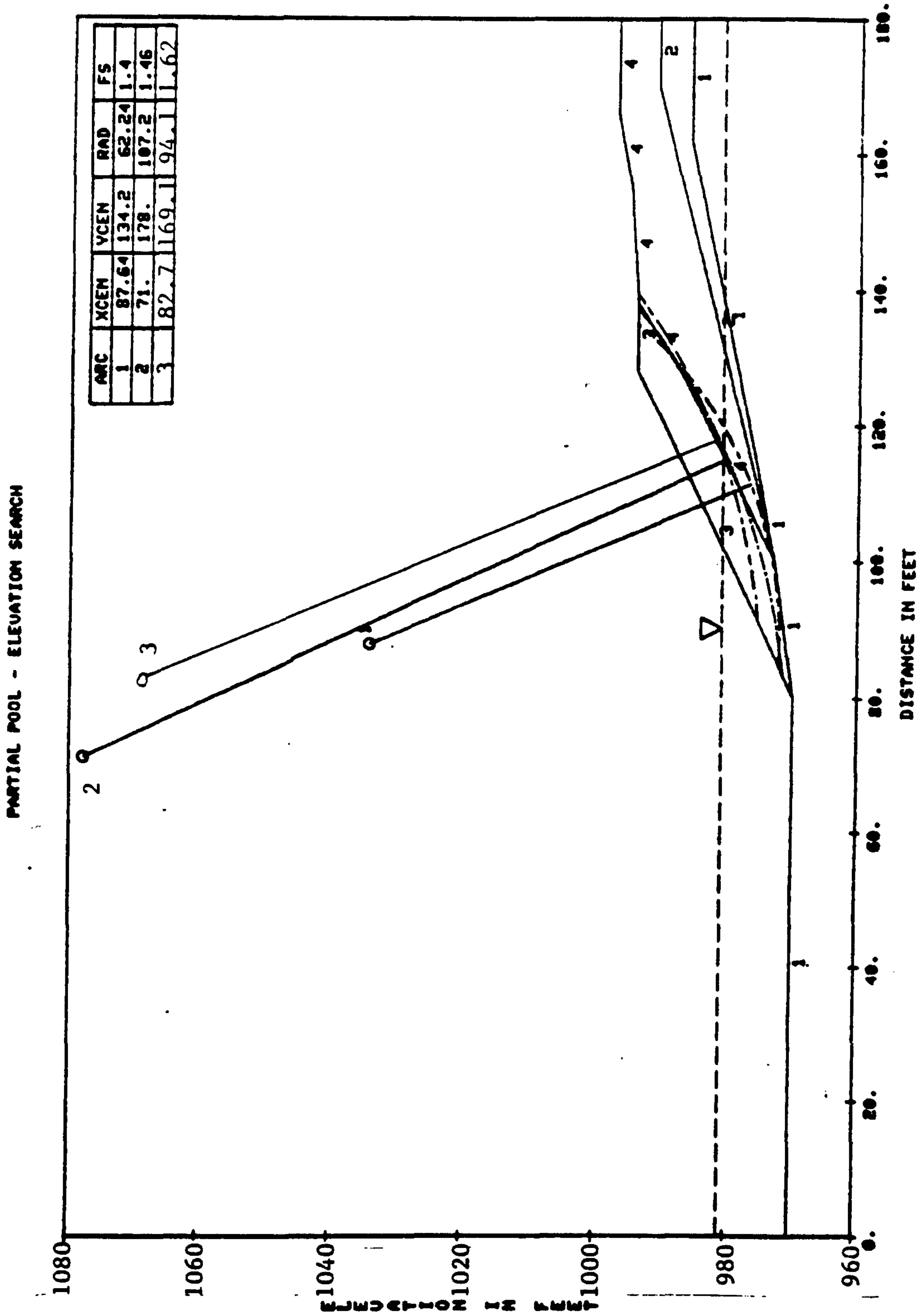
72.0  76    178    5    0.0
14 15      0.0
0 0 0 0 0 0 0 0
-5000      70      80      70     1
   80      70     100      73     1
  100      73     110      75     1
  110      75     162      86     1
  162      86    5000      86     1
   80      70     128      94     3
  128      94     138      94     3
  100      73     170      91     2
  170      91    5000      91     2
  100      73     127      87     4
  127      87     138      94     4
  138      94     155      95     4
  155      95     166      97     4
  166      97    5000      97     4
    1     160     160   10000    45     0     0
    2     135     138       0    38     0     0
    3     125     140       0    38     0     0
    4     110     120       0    30     0     0
    2
-5000      81
 5000      81
0
```

DESIGN MEMORANDUM NO. 2 PHASE IB . - FEATU
APPENDIX B - GEOT

FLOOD CONTROL
ROCHESTER, MINNESOTA

COMPUTER DATA FILE
STABILITY ANALYSIS RESULTS - STA. 186+75
PARTIAL POOL CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-76



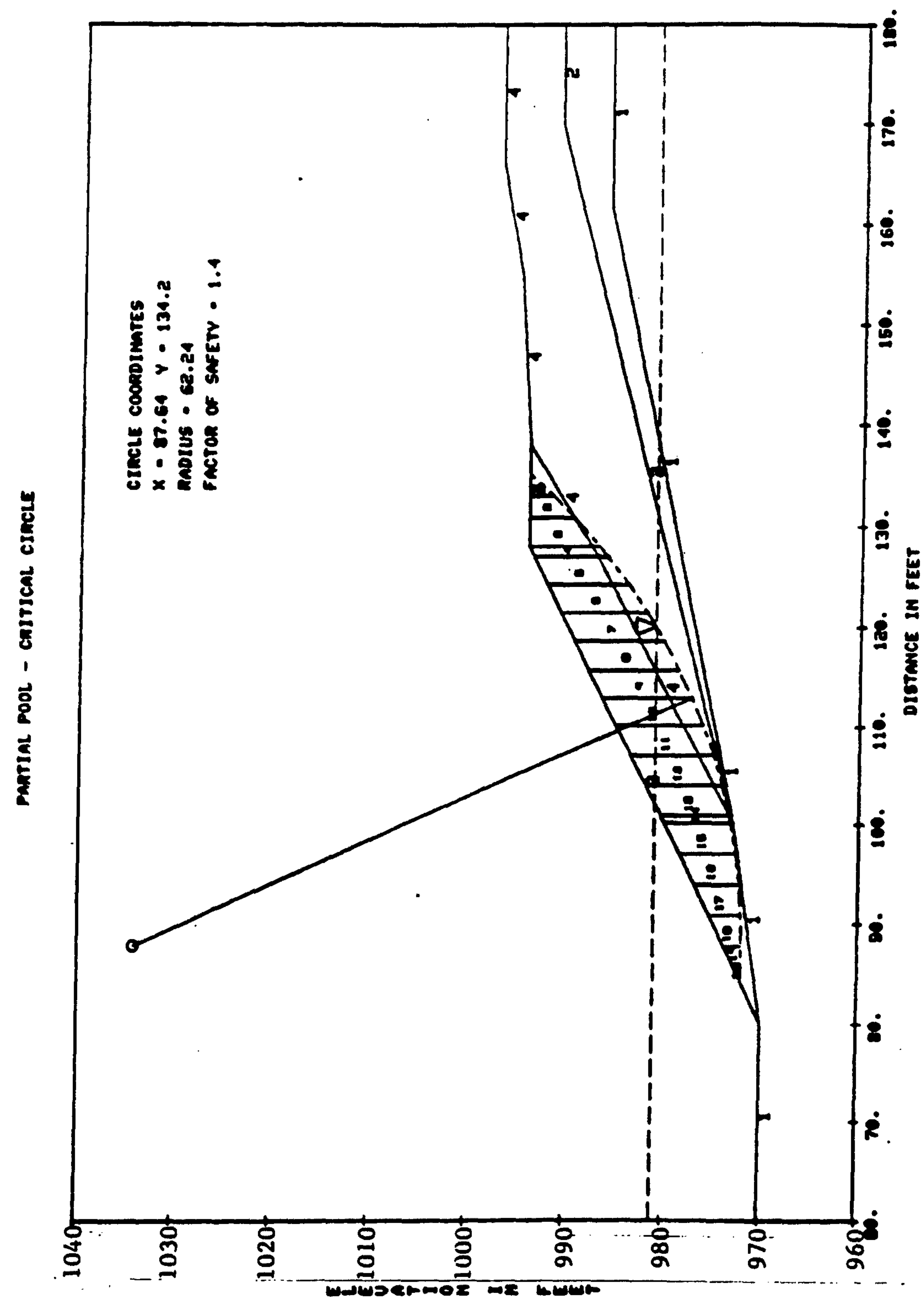
ARC	XCEN	YCEN	RAD	FS
1	87.64	134.2	62.24	1.4
2	71.	178.	107.2	1.46
3	82.7	169.1	94.1	1.62

DESIGN MEMORANDUM NO. 2 PHASE 1B . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

CIRCULAR SEARCH SUMMARY
STABILITY ANALYSIS RESULTS - STA. 186+75
PARTIAL POOL CASE

.t. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-77

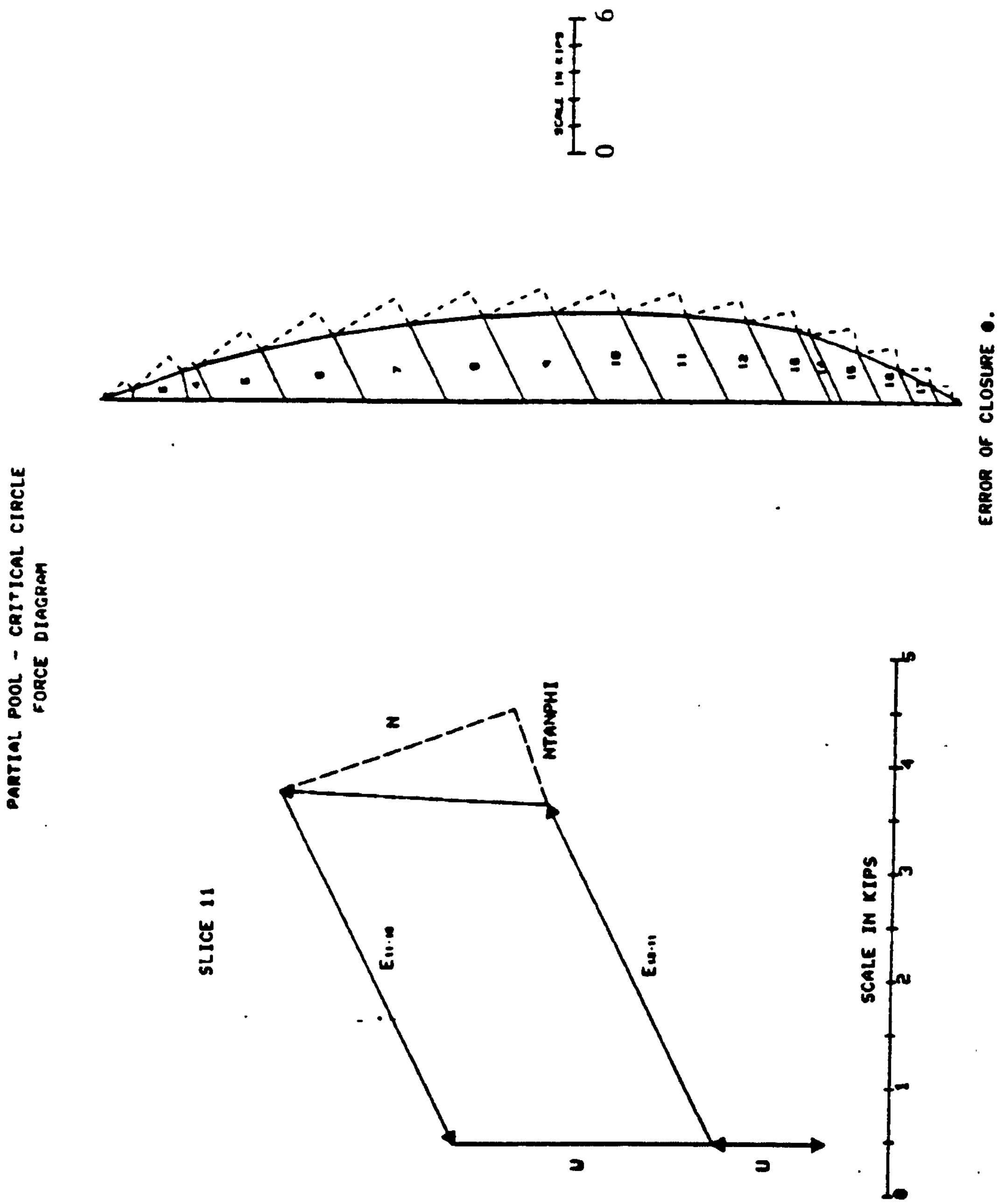


DESIGN MEMORANDUM NO. PHASE . - FEATURE
APPENDIX B - GEOT

FLOOD CONTROL
ROCHESTER, MINNESOTA

CRITICAL CIRCLE
STABILITY ANALYSIS RESULTS - STA. 1[illegible]5
PARTIAL POOL CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-78



DESIGN MEMORANDUM NO. 2 PHASE IB . - FEATURE
APPENDIX B - GEOTEC

FLOOD CONTROL
ROCHESTER, MINNESOTA

TYPICAL SLICE FORCE DIAGRAM
STABILITY ANALYSIS RESULTS - STA. 186+75
PARTIAL POOL CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-79

PARTIAL POOL - CRITICAL CIRCLE
TABULATION OF SLICE DATA

SLICE	SLICE WIDTH	SLICE COORD	SLICE WT	WATER FORCE	DIREC TION	DEVEL C-FORCE	DIREC TION	PHI DEVEL	NORM STRESS	NORM FORCE	ALPHA TOP	ALPHA BOT	E1	E2
1	2.13	134.1	.32	0.	0.	0.	48.23	29.16	.09	.3	0.	0.	0.	.11
2	2.13	131.9	.93	0.	0.	0.	45.37	29.16	.28	.84	0.	0.	.11	.38
3	2.87	129.4	2.09	0.	0.	0.	42.18	22.41	.47	1.81	0.	13.28	.38	1.07
4	1.	127.5	.9	0.	0.	0.	39.82	22.41	.4	.52	13.28	26.57	1.07	1.36
5	2.83	125.6	2.74	0.	0.	0.	37.56	22.41	.65	2.31	26.57	26.57	1.36	2.09
6	2.83	122.7	2.94	0.	0.	0.	34.34	22.41	.73	2.51	26.57	26.57	2.09	2.71
7	2.83	119.9	3.07	0.	0.	0.	31.24	22.41	.8	2.66	26.57	26.57	2.71	3.21
8	2.83	117.1	3.18	.28	90.	0.	28.23	22.41	.8	2.56	26.57	26.57	3.21	3.52
9	2.83	114.2	3.23	.53	90.	0.	25.31	22.41	.78	2.44	26.57	26.57	3.52	3.67
10	2.83	111.4	3.24	.76	90.	0.	22.46	22.41	.75	2.3	26.57	26.57	3.67	3.67
11	3.07	108.5	3.46	1.04	90.	0.	19.55	22.41	.7	2.3	26.57	26.57	3.67	3.53
12	3.07	105.4	3.34	1.23	90.	0.	16.57	22.41	.64	2.06	26.57	26.57	3.53	3.28
13	3.07	102.3	3.15	1.39	90.	0.	13.64	22.41	.56	1.79	26.57	26.57	3.28	2.95
14	.78	100.4	.75	.33	90.	0.	11.82	29.16	.57	.45	26.57	26.57	2.95	2.78
15	3.09	98.45	2.72	1.21	90.	0.	10.01	29.16	.54	1.68	26.57	26.57	2.78	2.07
16	3.09	95.36	2.25	1.	90.	0.	7.13	29.16	.47	1.47	26.57	26.57	2.07	1.36
17	3.09	92.27	1.72	.76	90.	0.	4.27	29.16	.38	1.19	26.57	26.57	1.36	.72
18	3.09	89.18	1.11	.5	90.	0.	1.42	29.16	.27	.83	26.57	26.57	.72	.23
19	1.72	86.78	.33	.15	90.	0.	-.79	29.16	.15	.26	26.57	26.57	.23	.06
20	1.72	85.05	.11	.05	90.	0.	-2.38	29.16	.05	.09	26.57	26.57	.06	0.

ALL FORCES IN KIPS
ALL ANGLES MEASURED FROM POSITIVE X-AXIS

DESIGN MEMORANDUM NO. 2 PHASE I/B . - FEATURE
APPENDIX B - GEOT

FLOOD CONTROL
ROCHESTER, MINNESOTA

SLICE DATA SUMMARY
STABILITY ANALYSIS RESULTS - STA. 186+75
PARTIAL POOL CASE

St. Paul District, U.S. Army Corps of Engineers
File No. January 1987
PLATE B-80

A D D E N D U M No. 1

TO

APPENDIX B

SILVER LAKE DAM MODIFICATIONS

-GEOTECHNICAL-

A D D E N D U M No. 1

TO

APPENDIX B

T A B L E O F C O N T E N T S

ADDENDUM No. 1

TABLE OF CONTENTS (Continued)

SOIL EXPLORATION COMPANY
662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-6446

a sister corporation to TWIN CITY TESTING AND ENGINEERING LABORATORY INC.

March 19, 1985

Short Elliott Hendrickson, Inc.
222 East Little Canada Road
St. Paul, MN 55117

Attn: Mr. David Pillatzke

Subj: Below Dam Seepage Control
Silver Lake Dam Modifications
Design Memo 2
Delivery Order 2
SEH File #85089-02
Rochester, Minnesota
SEC #120-13263

Gentlemen:

We have performed calculations and have prepared geotechnical engineering recommendations to assist you in designing the positive sheet-pile cutoff system for the proposed modification to the Silver Lake Dam located in Rochester, Minnesota. This work was conducted in accordance with your verbal authorization given on February 4, 1985.

Soil Exploration Company appreciates the opportunity of providing service on your project and looks forward to providing continued service, as needed, as the project progresses. If you have any questions or need additional information please contact us.

Very truly yours

William L. Lawyer, E.I.T.

Samuel Y. Ng, P.E.

WLL/SYN/raw

Encs.

REPORT OF BELOW DAM SEEPAGE CONTROL

SILVER LAKE DAM MODIFICATIONS

DESIGN MEMO 2

DELIVERY ORDER 2

SEH FILE #85089-02

ROCHESTER, MINNESOTA

SEC #120-13263

INTRODUCTION

Purpose

We have performed calculations and have prepared geotechnical engineering recommendations to assist you in designing the positive sheet-pile cutoff system for the proposed modification to the Silver Lake Dam located in Rochester, Minnesota. This work was conducted in accordance with your verbal authorization given on February 4, 1985.

Scope

Our authorized work scope is limited to the following items:

1. Review available background information.
2. Perform calculations pertaining to seepage and permanent tie back system.

3. Present the results of our calculations and provide general comments and opinions for design consideration for:

    a. A positive sheet-pile cut off system for below dam seepage control.

    b. Permanent tie back system.

    c. Embankment seepage control.

This report pertains only to item 3. a. The remaining items (3. b. and 3.c.) will be addressed in a future report.

AVAILABLE PROJECT AND BACKGROUND INFORMATION

We understand it is proposed to modify the existing structure. These modifications will include: a design of the hinged leaf gate, tainter gate, and access bridge, concrete repair and the foundation analysis and design.

To aid in our analysis, we were furnished with a copy of the condition survey for Silver Lake Dam prepared by Barrientos And Associates (contract DACW 37-34-D-0008).

ENGINEERING REVIEW

Assumptions

Our calculations for seepage beneath the structure are based upon assumptions made from the information available to us. If any discrepancies in these assumptions are found, we request that you contact our office so that we can review our results and make changes as necessary. Our assumptions are as follows:

I. The critical cross-section of the dam and soil parameters are as shown on the attached Plate 1.

II. For all practical purposes, impermeable bedrock is located at a depth of 50' below the dam.

III. The soil stratum is homogeneous and Darcy's law is valid.*

IV. The empirical "creep path" approach developed by E.W. Lane and his safe weighted-creep ratio for different soil types are valid. (Lane, E.W., "Security From Under-Seepage: Masonry Dams On Earth Foundations," Trans. Am. Soc. C.E., 1935. As presented in Taylor, D., Foundamentals Of Mechanics. New York; John Wiley & Sons, Inc., 1948-16th printing 1967, PP 550-555.)

V. The analytical method presented by Pavlousky of Method Of Fragments and his assumptions are valid. (Pavlousky, N.N., "Collected Works", AKAD. NAUK USSR, Leningrad, 1956. As presented in Harr, M.E., "Mechanics Of Particulate Media. New York, etc.: McGraw-Hill, Inc., 1977, PP 158-170.)

*In our opinion, there is little question of the validity of Darcy's law. However, the assumption of homogeneous soils is a simplification of the complex soil parameters which must be made in order to utilize most "acceptable" seepage analysis methods.

Typical Calculations

Plates 2 and 3 show typical calculations performed for the two methods presented above.

Safety Factors & Safe Values For Exit Gradients

The recommended safe value for the weighted-creep ratio is 6-7, based on fine to medium sand. [1]

The required factor of safety for the method of fragment is 6-7 for sands. [2]

Summary of Data

Plate 4 indicates, in tabular form, a summary of selected sheet-pile designs versus factor of safety and/or safe values for exit gradients. Estimated uplift pressures, based upon the method of fragments, are also shown.

Based upon conversations with you, we understand that the uplift pressures indicated tend to be slightly larger than the piezometric pressures measured in the field.

1. Taylor D.
2. Harr M.E.

Conclusions

Based upon the factor of safety and the safe factors presented, we suggest that a 25' upstream and a 25' downstream sheet-pile design be utilized. We also suggest that a 10' apron length upstream be used. Our calculations show that an 8.3 factor of safety using the method of fragments and a 7.3 safe value using the creep-path method may be anticipated.

Your estimates and field measurements indicate pressures of about 5' of water now exist at the north end of the dam. However, our calculations show uplift pressures of 8.1' on the heel and 6.5' of water on the toe could be realized. Therefore, we recommend that permanently installed instrumentation be placed beneath and downstream of the dam. This instrumentation would also give early indication of piping and scouring.

LIMITATIONS

The recommendations contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted engineering practices at this time and location. Other than this, no warranty is implied or intended.

This report was prepared by: William L Lawyer

William L. Lawyer, E.I.T.

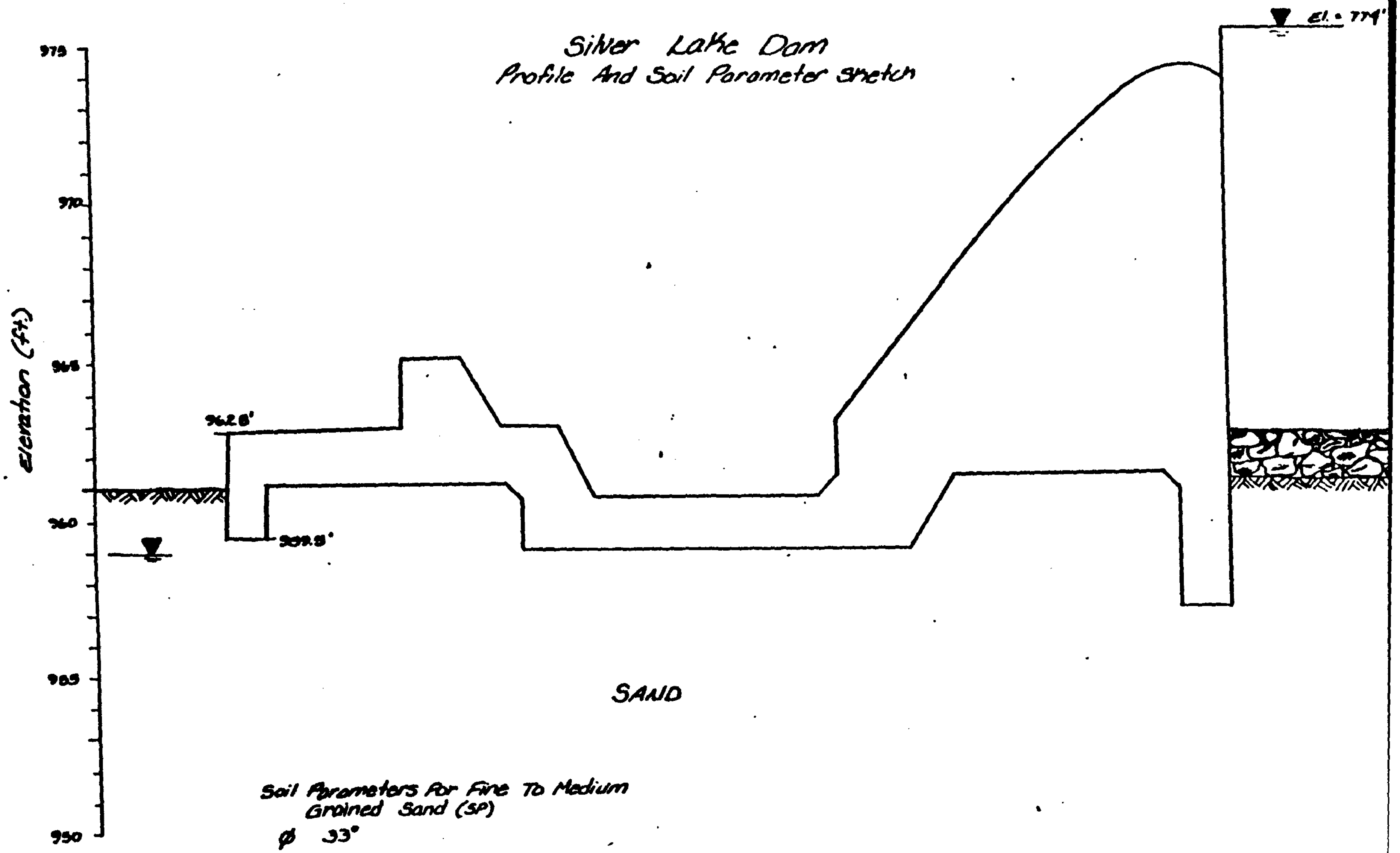
This report was reviewed by: [signature]

Samuel Y. Ng, P.E.

3-20-88 No. 11317

Proofread by: M. Cousteau

Silver Lake Dam
Profile And Soil Parameter Sketch



Soil Parameters For Fine To Medium Grained Sand (SP)

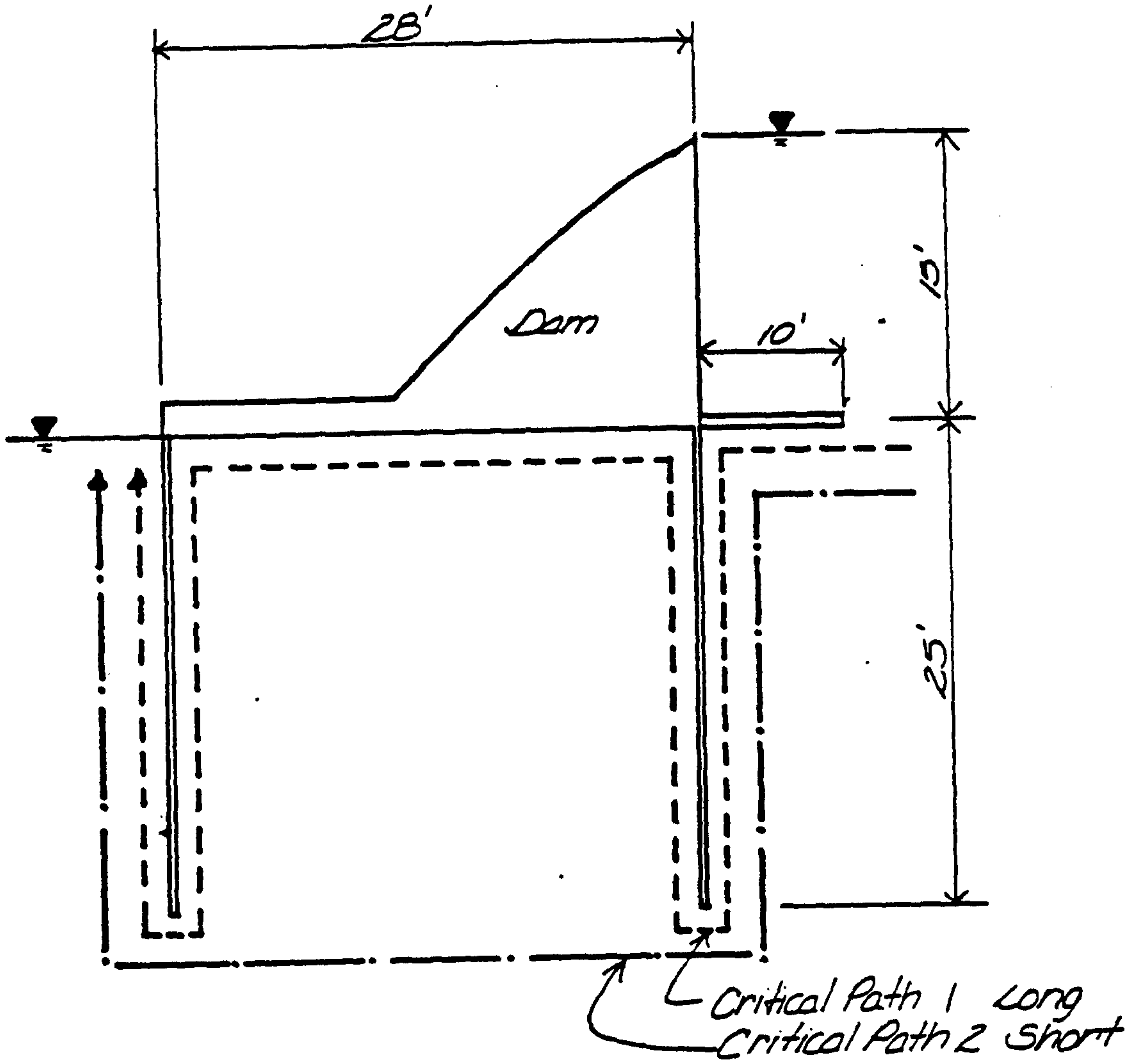
ϕ 33°
C 0
γ 130°
K_H 1×10⁻³

To-Bedrock
Elev. 911'
↓

PLATE I

SE-32(84-A) **soil exploration company**

JOB NO. 120-13263	SCALE: N.T.S.	DRAWN BY AB	CHECKED B



Path 1
Creep Ratio = $10/3 + 25 + 25 + 28/3 + 25 + 25 = \underline{\underline{112.6}}$

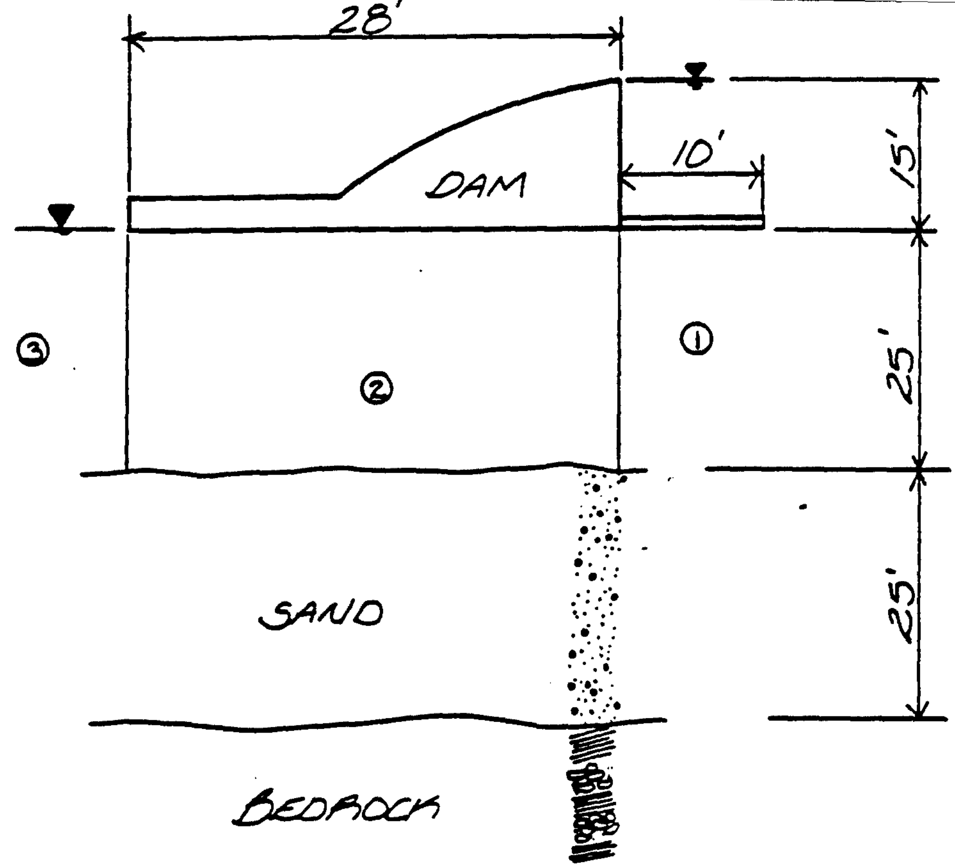
Path 2
Creep Ratio = $10/3 + 25 + (28 \times 2) + 25 = \underline{\underline{109.3}}$

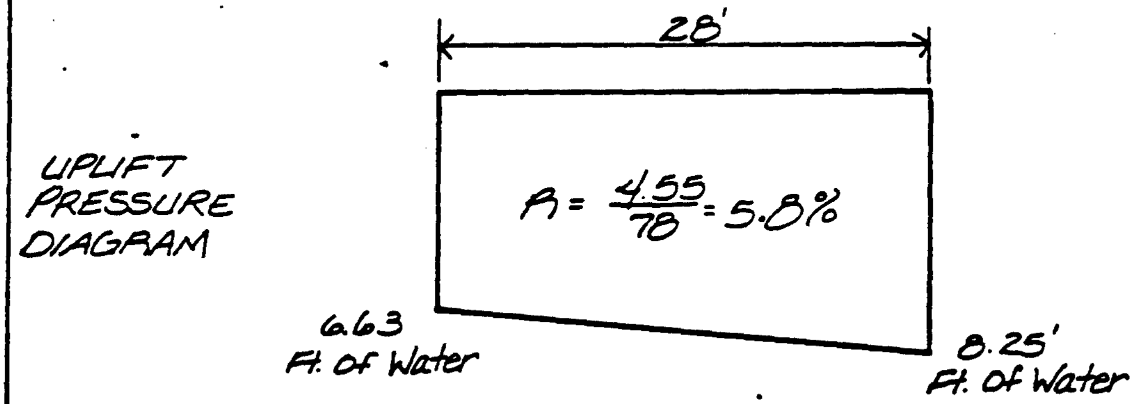
Safety Factor = Creep Ratio ÷ Differential Head =
$109.3/15 = \underline{7.3}$

PLATE 2

Creep Ratio Calculations	JOB NO. 120-13263	SCALE: N.T.S.	DRAWN BY [illegible]	CALCULATIONS BY W.L.

SE-14 (73A)





Fragment Section	Type	ϕ	Δh
1	III	Fig. 5-13 $\phi = 1.04$	5.31
2	V	$\phi = 2 \ln(1 + \frac{25}{50})$ $\phi = .889$	4.55
3	II	Fig. 5-13 $\phi = 1.0$	5.12
Total		2.929	15

PLATE 3

$I_E\ S/h = .59$ (Fig. 5-31) $\therefore I_E = \frac{.59(5.12)}{25} = .1208$ FS = 8.28

Method Fragments Calc.	JOB NO. 120-13263	SCALE: N.T.S.	DRAWN BY PB	CALCULATION BY

SE-14 (73A)

Summary Of Seepage Analysis

Calc. #	Depth Of Sheet Pile		Apron Length (ft)	FS *		Uplift Ft. of Water	
	upstream	downstream	upstream	Fragments	Creep Ratio	Heel	Toe
I	20	10	0	4.0	4.6	—	—
II	20	20	0	6.4	5.9	8.3	6.2
III	25	20	0	6.9	6.6	7.8	6.1
IV	25	20	12	7.1	6.9	7.7	6.0
V	20	25	0	7.6	6.6	8.9	7.1
VI	25	25	0	8.2	7.1	8.3	6.6
VII	25	25	10	8.3	7.3	8.1	6.5

* FS For Both Methods Should Be At Least 6 To 7.

PLATE 4

SE-32(84-A) SOIL EXPLORATION COMPANY | JOB NO. 120-13263 | SCALE: N/A | CALCULATIONS BY WLL

SOIL EXPLORATION COMPANY

PROJECT Silver Lake Dam DESIGNED BY WLL DATE 4-21-85
WORK ORDER NO. REVIEWED BY DATE

REVIEW COMMENTS

COPY

Seepage

PRELIMINARY DRAFT
Subject To Revision

around

Abutments

PAGE OF

SO-3.(82A)

SOIL EXPLORATION COMPANY

PROJECT ______ DESIGNED BY WLL DATE 9-21-85

WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

Assumptions

1. Horizonal flow around sheeting
2. Vertical flow beneath sheeting
3. Exit gradient ≈ hydraulic gradient
4. Typical cross-sections as shown

SO - 3.1 (82A)

PROJECT ______ DESIGNED BY WLL DATE 4-21-85
WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

South Abutment

1. Required Exit gradient ≤ 0.20

2. Assume Exit gradient will not exceed hydraulic gradient * 25%

   $\therefore$ hydraulic gradient $= i = \frac{0.20}{1.25}$

   $i_{cr} = 0.16$

3 Assume sheeting eff $= 75\%$

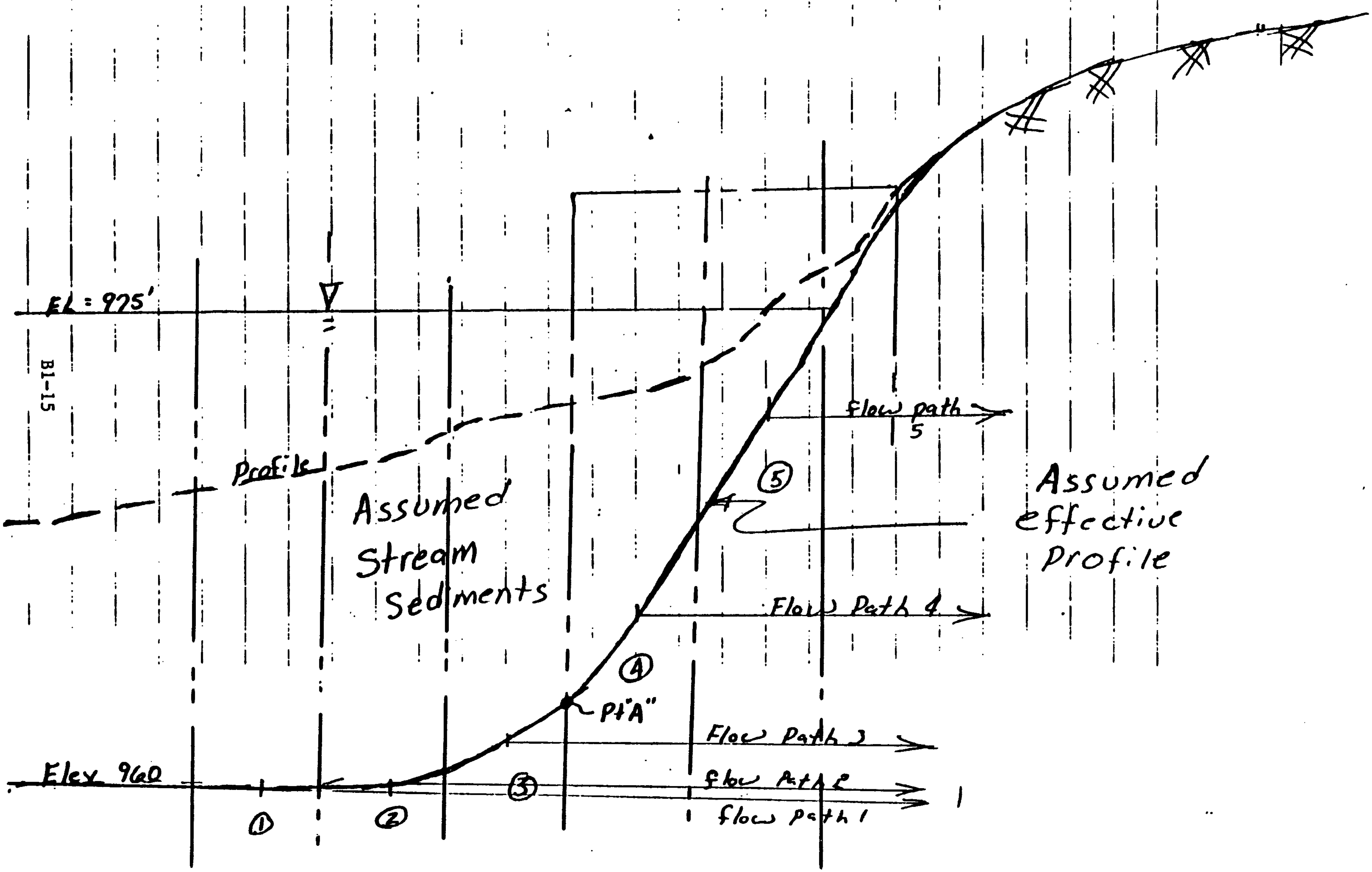
   $\therefore$ $i_{critical} = 0.16 * 0.75$

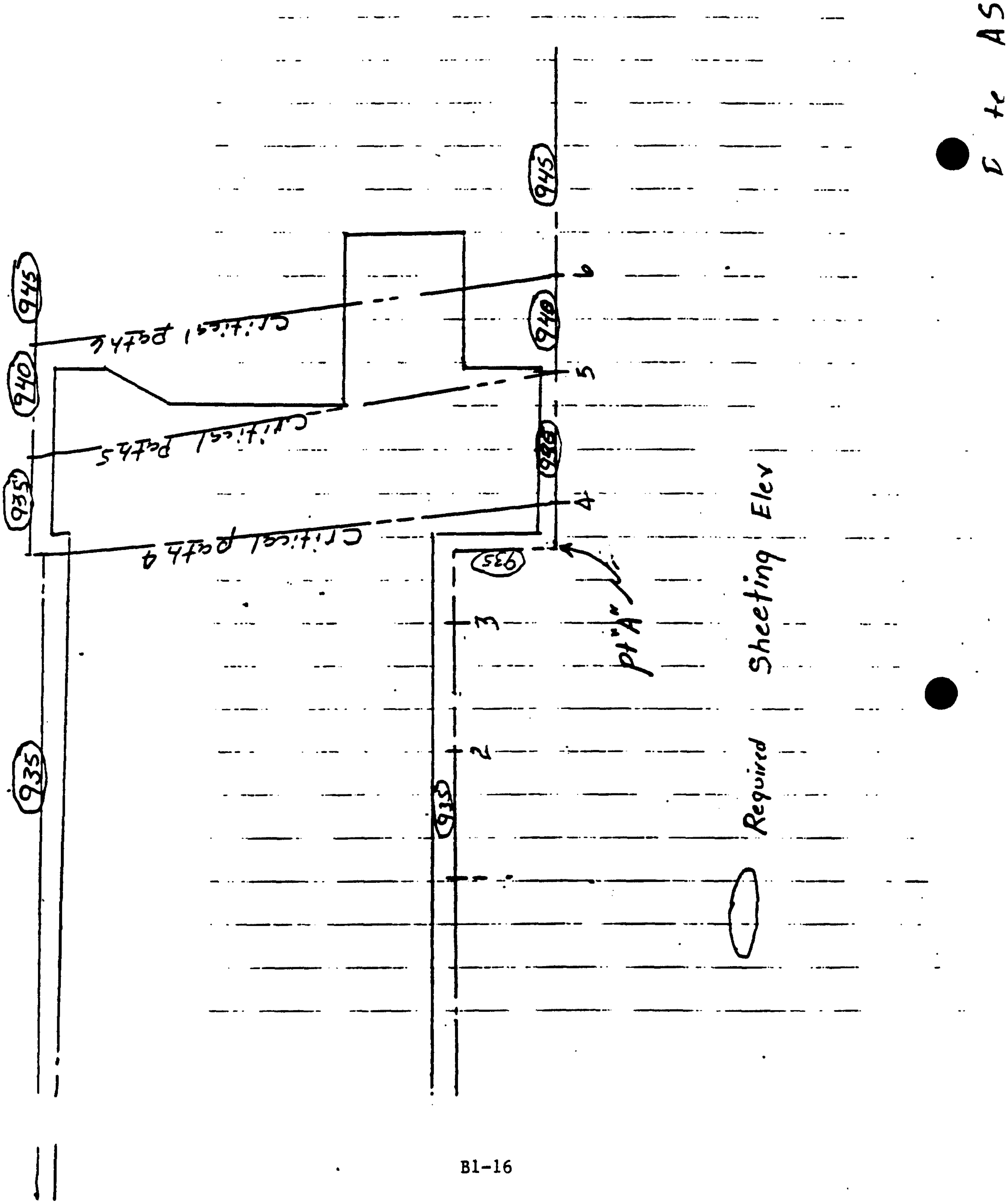
   $i_{cr} = 0.12$

Using Plates AS-1 & AS-2 the following table shows sheet pile lengths required past point "A"

PAGE

SO-3 1 (82A)


EL = 975'
Elev 960
Profile
Assumed Stream Sediments
Assumed effective Profile
Flow path 5
Flow Path 4
Flow Path 3
flow Path 2
flow path 1
Pt "A"
1
2
3
4
5



945
940
935
935
Critical Path 6
Critical Path 5
Critical Path 4
945
940
938
935
935
6
5
4
3
2
pt "A"
Required Sheeting Elev
E to AS-

SOIL EXPLORATION COMPANY

PROJECT ______ DESIGNED BY WLL DATE 4-21-85

WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

Horizontal Flow - South Abutment

Point	Δh	Safe Dist. "L"	Dist from Pt to Pt "A"	Additional flow Length required	
1	15'	125	25	100	
2	14'	117	15	102	
3	13'	108	5	103	*
4	10'	83	-5	89	
5	3'	25	-15	40	

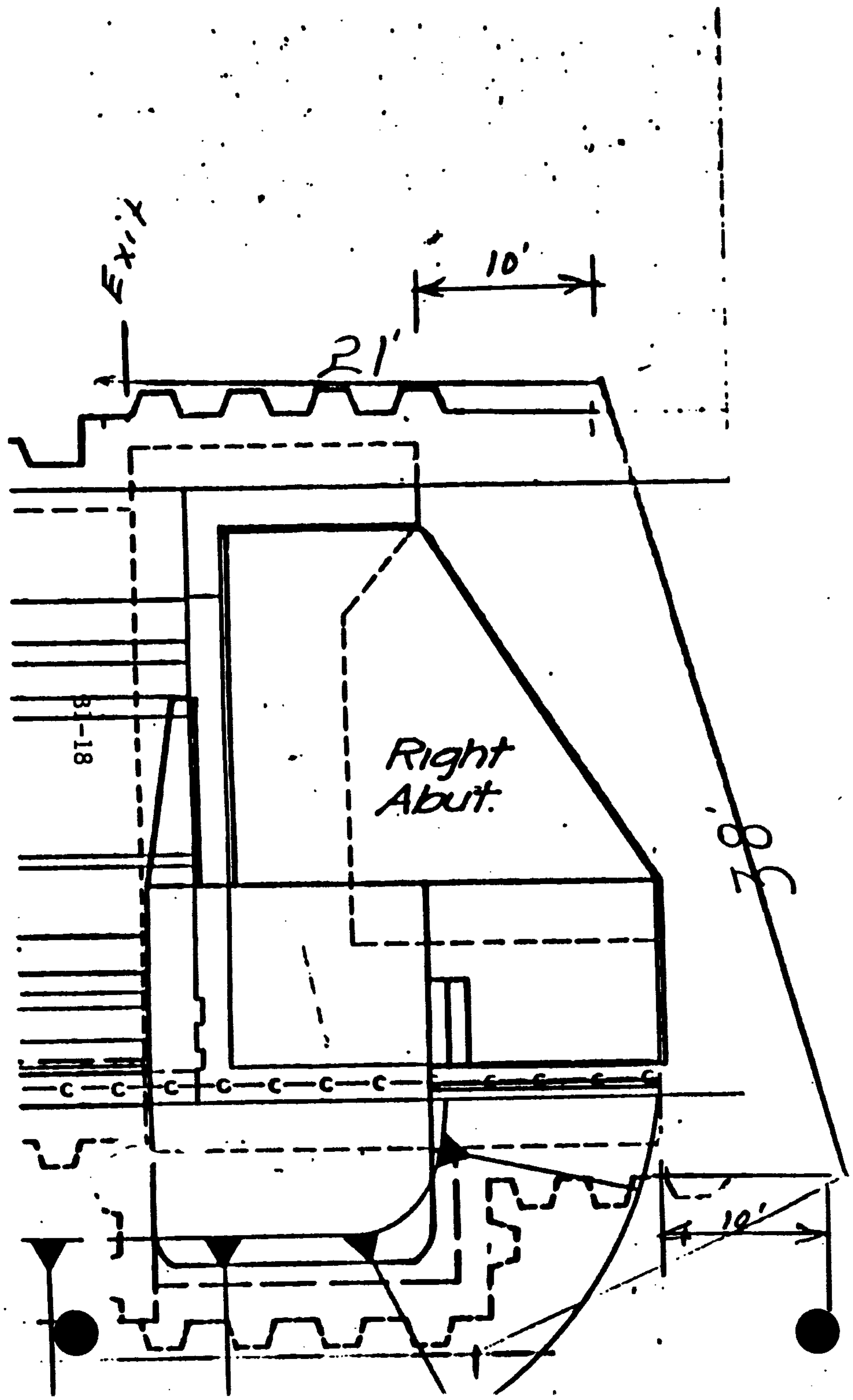
where $"L" = \Delta h' / i$

$= \Delta h' / 0.12$

* critical section

PAGE OF

SO-3.1 (82A)

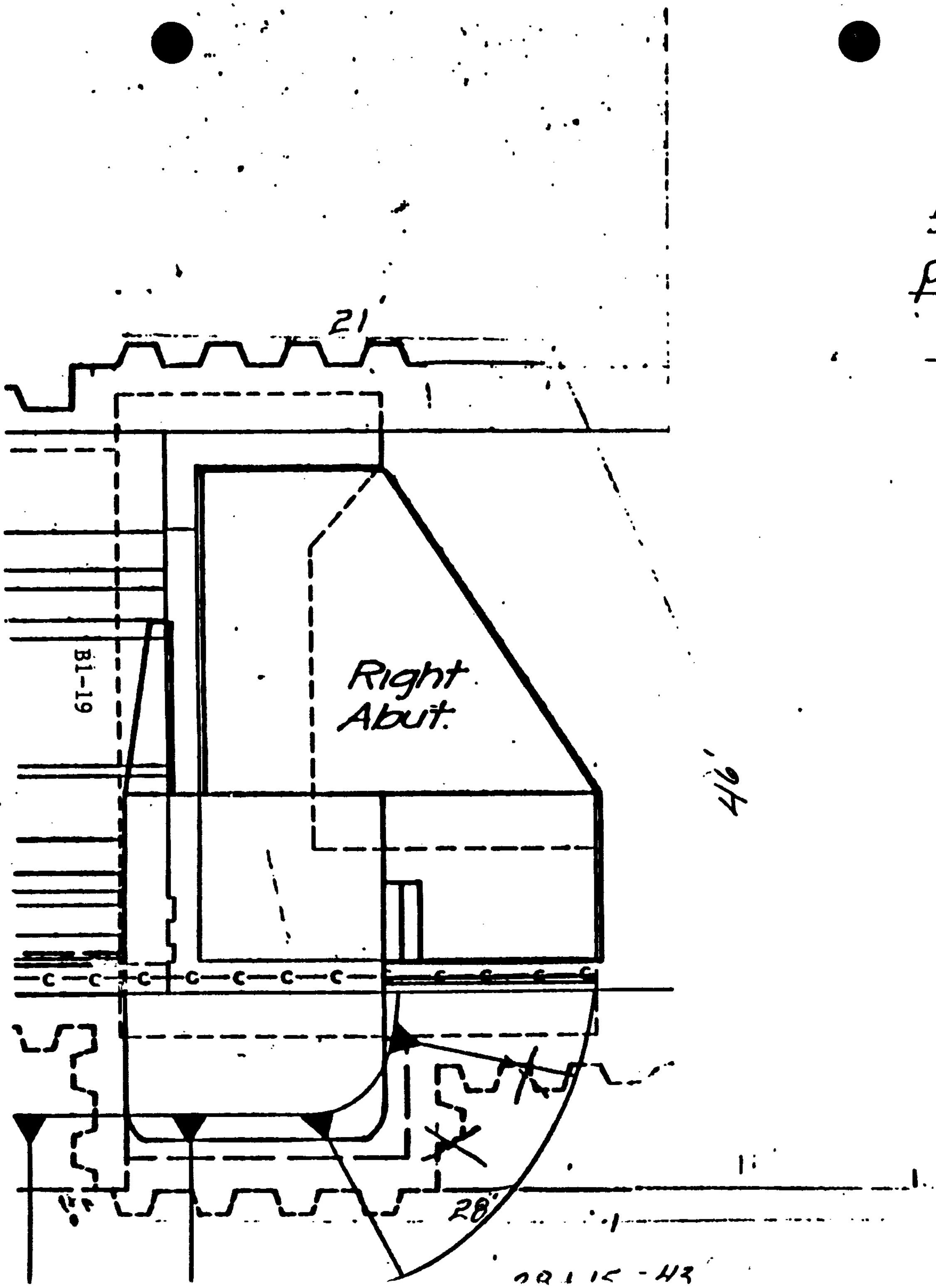


Try One

10' of sheet pile beyond ftg Upstream & Downstream

22' + 38' + 21' = 81'

∴ Need 22' additional

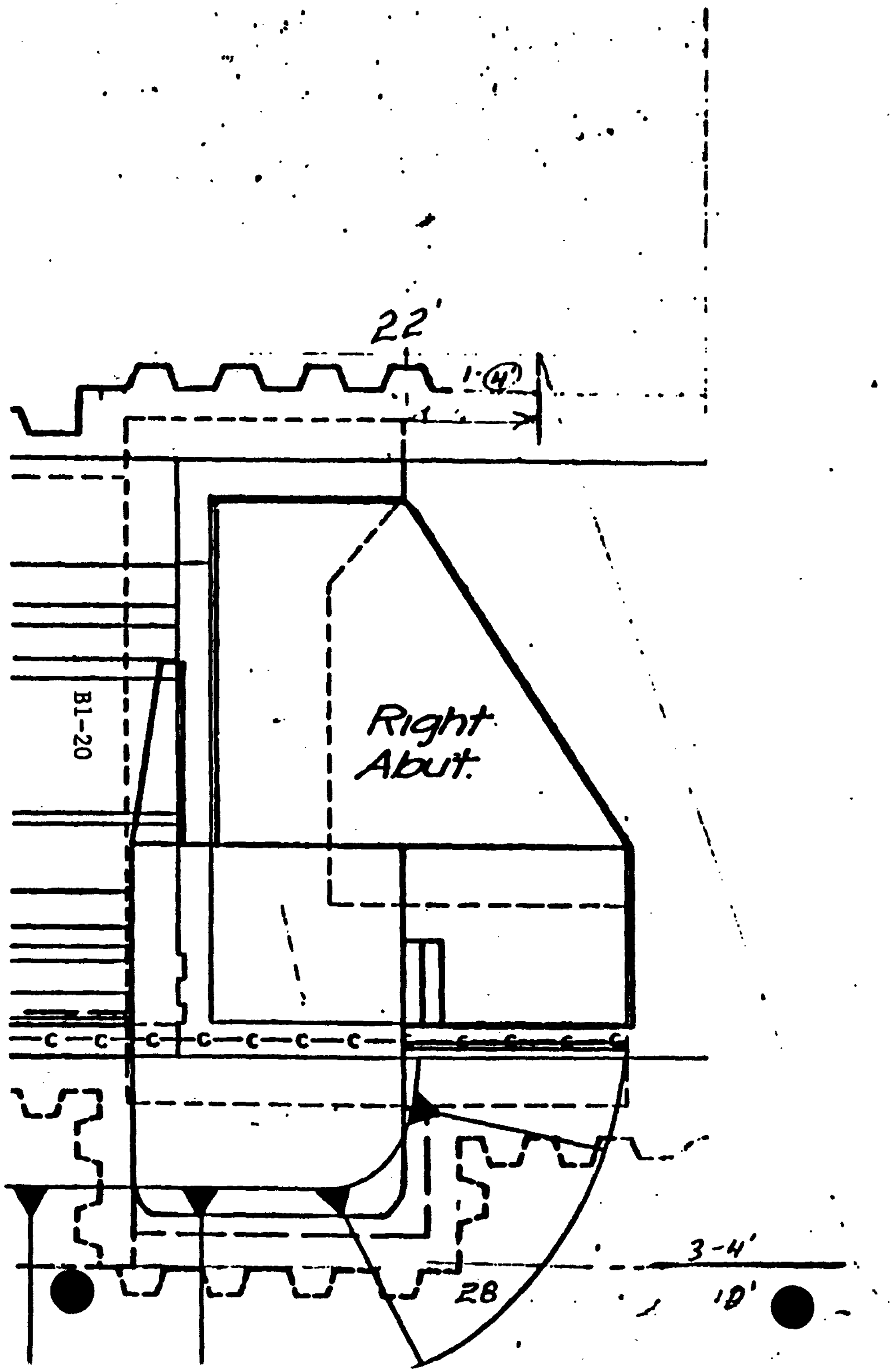


Try two

Extend Upstream Sheet-pile Straight for 15' past ftg

$43' + 46' + 21' = 110'$ say OK

$1/8'' = 1'$



Try three

USE: 6' beyond ftg downs
12' " " upstr

$40' + 44' + 22 = 106'$

Say OK

SOIL EXPLORATION COMPANY

PROJECT ______ DESIGNED BY ______ DATE ______

WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

Depth of Sheet-Pile

(using creep-path method)

1. Creep-ratio = weighted ratio % Δh

2. Safe creep ratio = $5\frac{1}{2}$ % 75% eff.

= 7.3

3. Using Δh = 15' (points 1-5)

then weighted ratio (safe) = 7.3 * 15

= 110

SO-31 (82A)

PROJECT ______ DESIGNED BY ______ DATE ______

WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

1. Points 1, 2 & 3

Depth prev. determined behind dam section

PAGE OF

SO - 3.1 (82A)

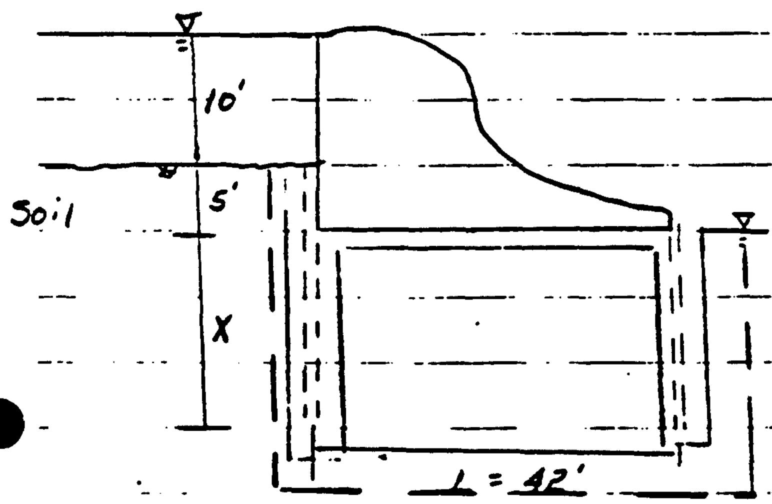
SOIL EXPLORATION COMPANY

PROJECT ______ DESIGNED BY ______ DATE ______
WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

2. Point 4 - vertical flow

Using critical path 4
on Plate AS-2 :



Find depth (X)

Path 1

$$\text{Weighted ratio} = 5 + 2X + \tfrac{42}{3} + 2X = 110 \quad (cr)(\Delta h)$$

$$19 + 4X = 110$$

$$X \cong 23'$$

Path 2

$$5 + 42(2) + 2X = 110$$

$$X \cong 11'$$

∴ Path 1 critical

Drive sheeting to elevation 935'

PAGE OF

SO - 3.1 (82A)

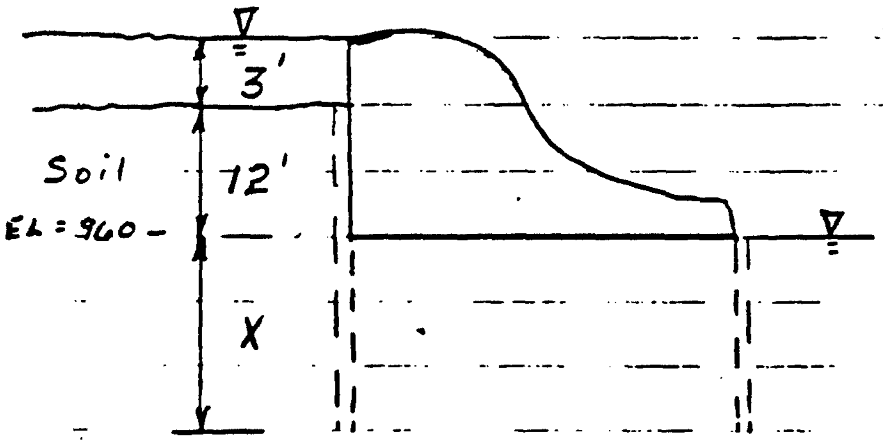
PROJECT ______ DESIGNED BY ______ DATE ______

WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

3 Point 5

Using critical path 5 on plate AS-2



Determine path 1 on

Find Depth (X)

Weighted ratio $= 12 + 2X + 42/3 + 2X = 110$

$\therefore X = 21'$

<u>Drive sheeting to elev 940</u>

SO-31 (82A)

SOIL EXPLORATION COMPANY

PROJECT ______ DESIGNED BY WLL DATE 4-21-85
WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

Pt 6 - critical Path 6 - No free water

$\Delta h = 15' - 28^{*}(.17)^{**} = 10.2'$

Path 1

$2X + 42/3 + 2X = (10.2)(7.3)$

$X = 15'$ or Elev 945'

Path 2 - not determined

* flow path Lengh - horizontal
** i

PAGE OF

SO 31 (82A)

PROJECT ______ DESIGNED BY ______ DATE ______
WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

North Abutment

1. Required Exit gradient = 0.20

2. Assume Exit gradient will not exceed hydraulic gradient * 25%
∴ critical hydr. grad = 0.16

3 Assume sheeting eff: 75%

∴ $i_{critical}$ = 0.12

4. Using plates AS-3 & AS-4

5. Assume const. head at existing sheet pile of 15'

PAGE ____ OF ____

SO-3 (82A)

Try two - North.

Extend upstream 16'(y) & downstream 16' in the down stream direction (X)

Required $L = \frac{\Delta h}{i} = \frac{15}{0.12} = 125'$

$L_{Try\ two} = 107 + 20 = 127$

Say OK

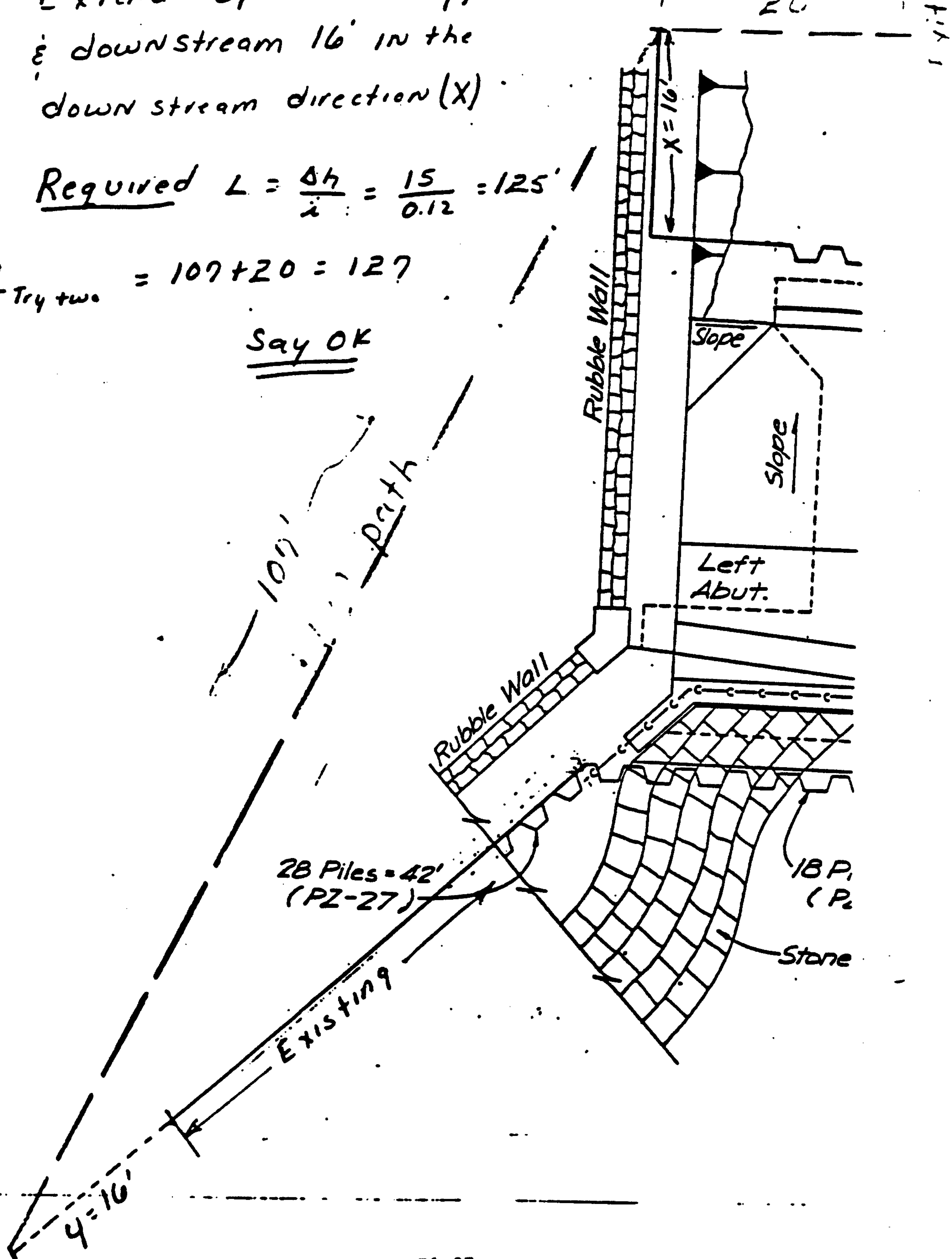
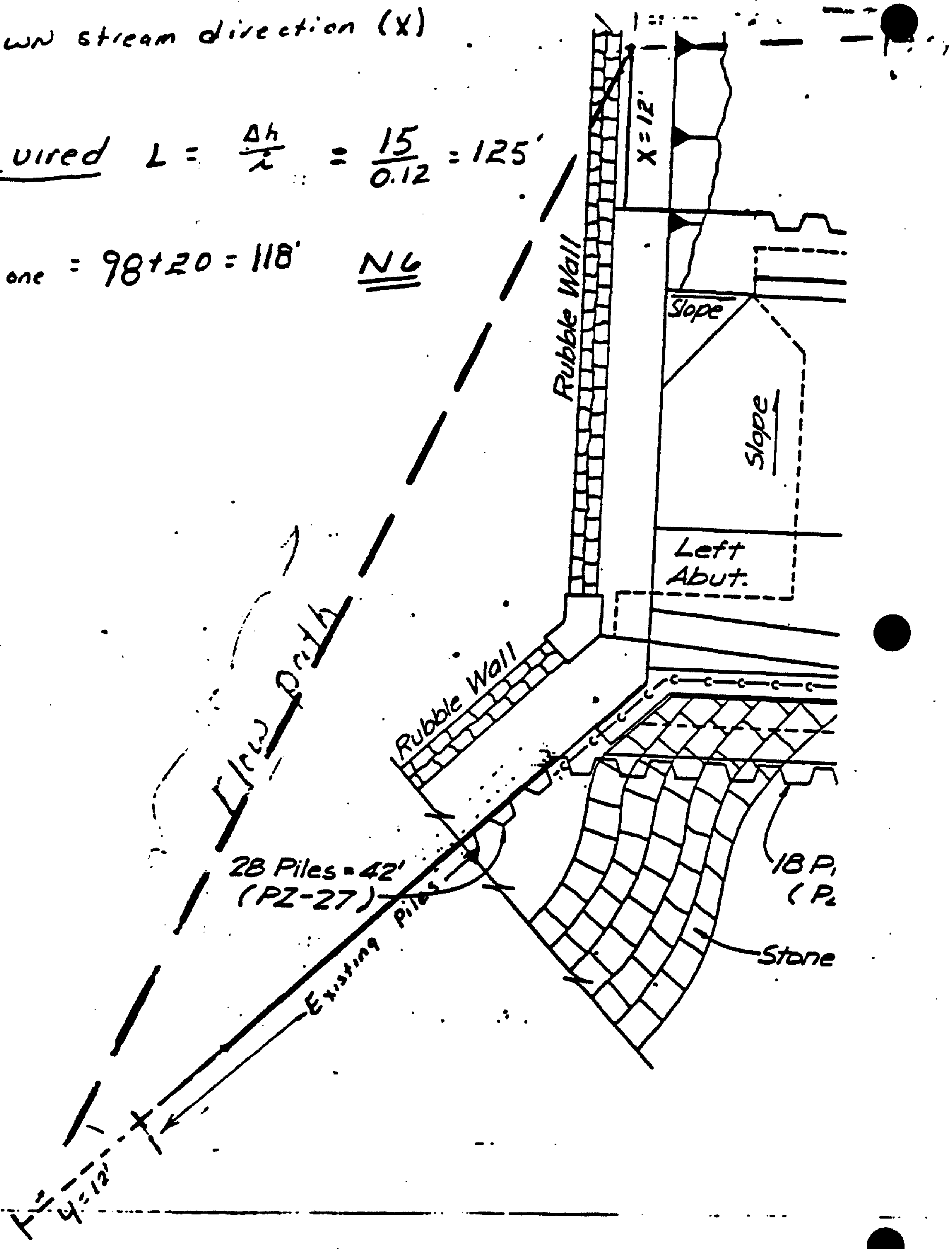


Plate AS-4

Try one – North
extend upstream 12' (y)
& downstream 12' in the
down stream direction (X)

Required $L = \frac{\Delta h}{i} = \frac{15}{0.12} = 125'$

$L_{Try\ one} = 98 + 20 = 118'$ No



3/32" = 1'

SOIL EXPLORATION COMPANY

PROJECT ____ DESIGNED BY ____ DATE ____
WORK ORDER NO. ____ REVIEWED BY ____ DATE ____

REVIEW COMMENTS

Summary

I South Abutment

1. Use 6' of sheeting beyond ftg down stream to depths indicated on Plate AS-2

2. Use 12' of sheeting beyond ftg upstream to depths indicated on Plate AS-2

II North Abutment

1. Use 16' of sheeting downstream going down stream next to rubble wall to an elevation of 935'

2. Extend sheeting 16' upstream along existing wall to elevation 940'.*

* Assume existing is driven to elev 940

SO-3 1 (82A)

CALCULATIONS

FOR

PRESTRESSED SOIL ANCHORS

SILVER LAKE DAM

ROCHESTER, MINNESOTA

#120-13263

LIST OF SYMBOLS

D	-	Anchor diameter
$D_{(10)}$	-	Grain size where 10% of the soil particles are smaller
$D_{(60)}$	-	Grain size where 60% of the soil particles are smaller
$l_{(a)}$	-	Anchor length
n	-	Imperical factor used in estimating type and capacity
$P_{(u)} = P_{(d)esign}$		Ultimate tie back capacity
Pi	-	Effective grout pressure
U	-	Uniformity coefficient
$Tow_{(ult)}$	-	Ultimate bond stress
Φ	-	Angle of internal friction
π	-	3.1416

NOTE: P_{design} equals maximum load anticipated times a factor of safety.

SOIL EXPLORATION COMPANY

PROJECT Silver lake DESIGNED BY WLL DATE 4-15-85
WORK ORDER NO. 120-13263 REVIEWED BY DKS DATE 4/20/85

REVIEW COMMENTS

Assumptions

1. Bedrock at least 50' below structure (ie: elevation 910' maximum)

2. Tie backs installed at alternating 35° & 45° (from horizontal) at $6\frac{1}{2}$' (c-c) spacing

3. High pressure injected (prestressed) tie backs will be utilized. Minimum injection pressure equals 150 psi.

4. The soil profile assumed is shown on Plate SP-1. The soil paremeters from samples retrieved from boring 81-44 M are assumed representative through out influence area.

Assumed Parameters

from elevation 940' to 910' are:

classified as SP (Unified)

		Size	% Passing
D_{60}	= 0.86	3/4"	98%
D_{30}	= 0.35	4	91
D_{10}	= 0.18	10	81
$U = \frac{D_{60}}{D_{10}}$	= 4.8	200	4

SO-3 1 (82A)

We wish to point out that boring 80-14M does indicate much higher bedrock than the assumed elevation of 810'. It indicates an elevation of bedrock of 838'.

The bedrock elevations should be verified throughout the area where tie backs are proposed. If bedrock is encountered within the required influenced area, an alternate tie back system and design may be required in these areas.

I. Estimate 1 - Littlejohn method (1)

$P_u = l_a \; n \tan \phi$

where P_u: Ult. anchor capacity
l_a : anchor length
n : empirical factor use $n=10$
(see ref)
ϕ : angle of internal friction

This equation is for low-pressure
∴ it could be increased by $\Delta T = 0.3 \Delta P$ (2)
but for 1st try will be left as-is.

P_{design} = 30 Ton anchor *(FS) use FS: 2.5*
the use of 2.5 for factor of saftey is due
to (in large) the limited soil data available.

∴ P_{design} 75 TONS = 150 Kips *
assume $\phi = 35°$
$n = 10$ Kips/ft

∴ $\underline{\underline{l_a}} = \frac{P_{design}}{n \tan \phi} = \frac{150}{(10)(\tan 35)} = \underline{\underline{21.4'}}$

* Not actual design load - just for estimate

II. Estimate ℓ : Little john[(1)] & Nicholson method[(3)]

$P_{ult} = p_i \, \pi \, D \, \ell_a \tan\phi$

$\therefore \ell_a = P_{design} / p_i \, \pi \, D \tan\phi$

assume $D = 5'' = 0.417'$

by definition p_i maximum $= 2$ psi/ft

$\Rightarrow$ assume $20' \times 2 = \underline{\underline{40}}$ psi $= 5.76$ Ksf

$\therefore \ell_a = 150 / (5.76)(\pi)(.417)(\tan 35°)$

$\underline{\ell_a} \cong \underline{28'}$

Again this is a low-pressure method and this value can be reduced because of prestressing effects

SOIL EXPLORATION COMPANY

PROJECT Silver lake DESIGNED BY WLL DATE 4-15-83
WORK ORDER NO. 120-13263 REVIEWED BY DKS DATE 4/20/85

REVIEW COMMENTS

III Ostermayer curve method (4)

Using

P_{design} = 150 kips

$U = \frac{D_{60}}{D_{10}}$ (soil) = 4.8 and in

medium Dense condition

Using the Ostermayer Ultimate capacity of a pressure-Injected tie back from design curve would be:

15' to 25' of anchor required

PAGE OF

SC 31 (62A)

SOIL EXPLORATION COMPANY

PROJECT Silver lake Dam DESIGNED BY WLC DATE 4-16-83
WORK ORDER NO. 120-13263 REVIEWED BY DKS DATE 4/20/85

REVIEW COMMENTS

IV Jorge curve Method (5)

Using

P_{design} 150 kips

soil : medium alluvial sands

The ultimate rate of load transfer from Jorge curves would be:

7 kips./ft for 150 psi grout pressure

$\therefore$ l_a = 150 kips / 7 kips/ft = 21.4'

SO 3 (82A)

SOIL EXPLORATION COMPANY

PROJECT Silver Lake Dam DESIGNED BY WLL DATE 4-16-85
WORK ORDER NO. 120-13262 REVIEWED BY DKS DATE 4/20/85

REVIEW COMMENTS

V Mori curve method[2]

assume $E \cong 180$ TSF
and effective grout pressure = 150 psi

$\therefore$ from Fig 6[2]

the Shear strength would be 3 TSF

if $D = 0.417'$

$\therefore l_a = 150^{Kips} / (3\ TSF)(\pi)(0.417)[(2)\frac{Kips}{Ton}]$

$l_a = 19.1'$

PAGE OF

SOIL EXPLORATION COMPANY

PROJECT Silver lake Dam DESIGNED BY L Lawyer DATE 4-16-85
WORK ORDER NO. 120-13263 REVIEWED BY DKS DATE 4/20/85

REVIEW COMMENTS

Summary of anchor lengths (bond)

Method	Assumed Pressure (grout)	Estimated l_a
I	< 150 psi	21.4'
II	< 150 psi (40)	28'
III	Maximum obtainable	15'-25'
IV	150 psi	21.4'
V	150 psi	19.1'

We suggest using a minimum 25' anchor (bond) length. This is slightly higher than the estimates show. However, the majority of the cost of an anchor is in the set-up, concrete drilling and stressing

SO-3 (182A) PAGE OF

SOIL EXPLORATION COMPANY

PROJECT Silver lake DESIGNED BY WLL DATE 4·16·85
WORK ORDER NO. 120-13263 REVIEWED BY DKS DATE 4/20/85

REVIEW COMMENTS

and not in the additional footage. In our experience, most contractors would install a minimum 25' anchor in most cases.

We wish to point out that the actual length is to be determined by the contractor (installer) This depth is a minimum, not an actual design.

SO - 3.1 (82A)

120-13263

UNBONDED (STRESSING) LENGTH

Based upon the post-tentioning institute[6] under 5.2.5, Free Stressing Length, this reference states "Minimum stressing length of 15' to 25' are recommended for all soil anchors. The minimum stressing lengths recommended are necessary so that small movements of the stressing anchor will not result in large changes in load."

We recommend that a minimum unbonded length of 20' be used for the above stated reason and so that the anchor will be in the less silty (SP) sands.

GROUP EFFECTS

In our opinion, based on information by the post-tentioning institute,[6] group interaction will be minimal and does not influence the design. This reference states under section 5.2.2, System Design, "The interaction of groups of anchors must be considered when the spacing is close." However, they go on to say "Research to date has shown that a spacing of six (6) times the grout bult diameter, there should be no interaction".

In our experience, 5 to 6 inch anchor diameters are usually utilized. However, even if we assume a 12" diameter, the critical spacing would be 6x12" = 72". This design, even without skew, has a spacing of 6½ of 78".

ANCHOR STRESSING AND TESTING

We recommend that load tests on the soil anchors be performed in accordance with PTI (Post-tentioning Institute) procedures. These procedures will be outlined in depth in the final report.

PROTECTIONS

We recommend that the anchors and stressing cables be protected as necessary.

SUMMARY OF OUR RECOMMENDATIONS

We recommend that minimum design standards be utilized which consist of 20' of unbonded (stressing) length and a minimum 25' bond length. We also recommend that a testing program be utilized and should conform with the Post-Tensioning Institute recommendations. We further recommend that the permanent anchor systems be protected from corrosion as necessary.

We sulggest that a minimum of 150 psi grout pressure be utilized and that the anchors should be capable of being regrouted.

We recommend that the anchors be load tsted to 1.5 of the design load for the anchor. Eor a maximum anticipated load of 30 tons, the design load would be 60 tons usinig a factor of safety of 2.0

We recommend that our performance specifications be utilized. This specification usually enables the contractor to provide his most economical tie back while still maintaining the requirements of the design.

We highly recommend that a detailed geotechnical site investiagtion be performed to determine the extent of the various soils encountered in the testing program already performed.

As shown in our calculations, the factor of safety was 2.5. This value was for estimates only. We recommend that the actual factor of safety should be 2.0.

120-12262

REFERENCES

1. Littlejohn, G.S., "Soil Anchors", Ground Engineering, precedings of an ICE Conference, June 16, 1970, ICE, London, Tp. 36-40, 1970.

2. Mori, Hiroshi, "PRestressing Effects In The Ground And Application", Soil Engineering, precedings of a South East Asian Regional Conference, Bancock, Tp. 529-537, 1967.

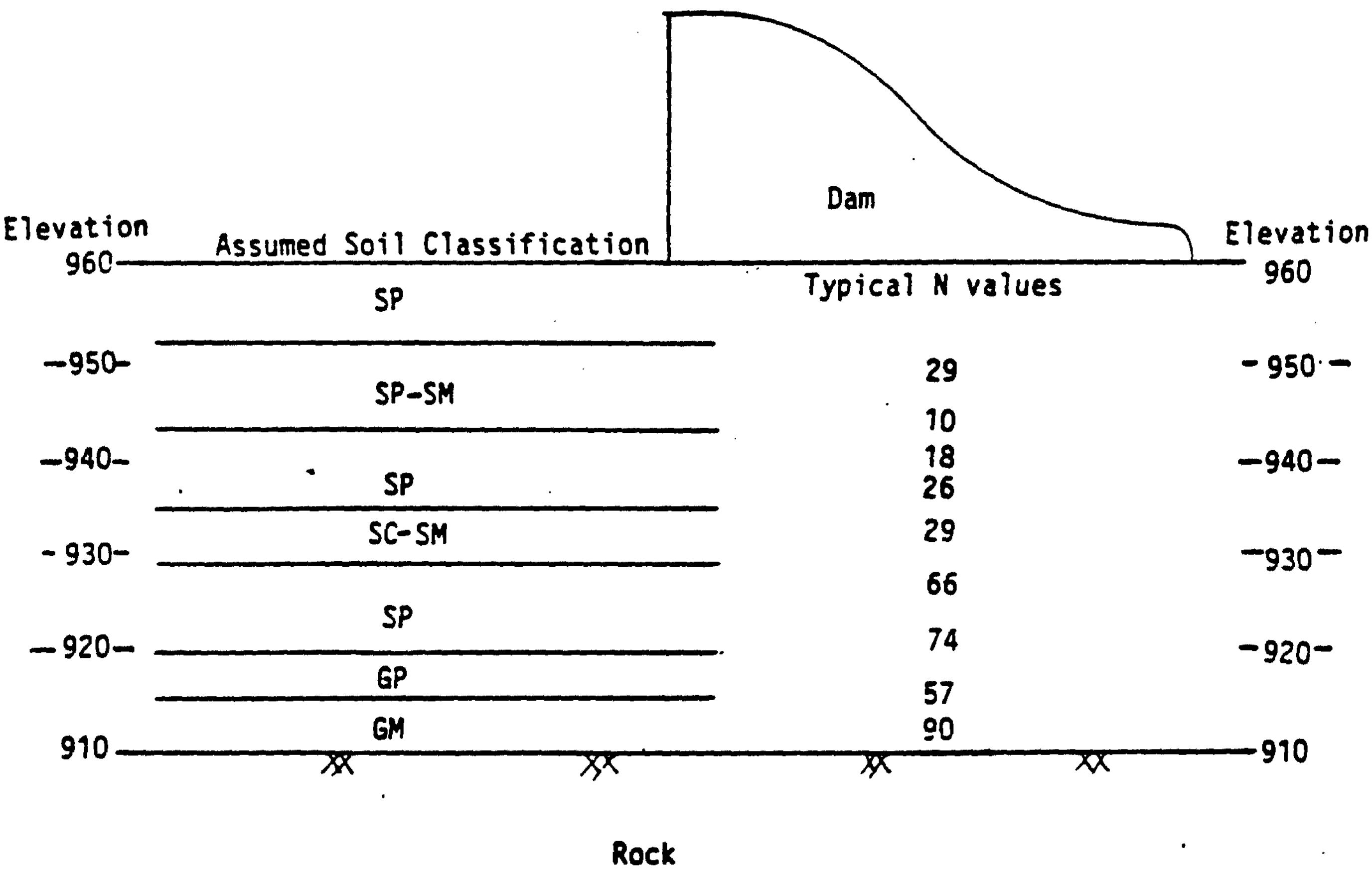
3. Nicholson Construction, Rock and Soil Anchor Manual, P.O. Box 98, Dridgeville, PA 15017.

4. Middleton, H. "Raising the Airgale Dam", The Consulting Engineer, Volume 2, 1961.

5. Jorge, G.R., "The Regroutable Irp Anchorage ForSoft Soils, Low Capacity or Karstic Rocks", Paper #15-10, VII ICSMFE, Specialty Sessions #14 and 15, pages 159-163, 1969.

6. Post-tentioning Institute First Addition, First Printing, 301 West Osborne, Suite 3500, Phoenix Arizona 85013, 1980.

TYPICAL SOIL PROFILE
(ASSUMED)



COPY

POST-TENSIONING INSTITUTE

301 W. Osborn, Suite 3500 / Phoenix, Arizona 85013
Telephone (602) 265-9158

April 16, 1985

Mr. Bill Lawyer
Soil Exploration Co.
662 Cromwell Avenue
St. Paul, MN 55122

Dear Mr. Lawyer:

This is to confirm our telephone discussion in which I gave you oral permission to reprint pages from the PTI publication, "Recommendations for Prestressed Rock and Soil Anchors" in a report in reference to a Corps of Engineers project.

A copy of the rock and soil anchor recommendations is enclosed.

Yours very truly,

Clifford L. Freyermuth
Executive Director

CLF/bs
Enclosure

SOIL EXPLORATION COMPANY

PROJECT Silver lake Dam DESIGNED BY Lawyer DATE 3-26-85
WORK ORDER NO. 120-13263 REVIEWED BY [signature] DATE 4-18-85

REVIEW COMMENTS

COPY

Bearing Capacity

for Abutments - assuming

no pile action.

Assume: Full soil contact

Ftgs @ EL.=960'

No Pile action

No reduction for eccentricity or inclination of applied loads.

Ø' based on Standard penetration resistance (N) obtained from boring logs 80-13M and 80-14M. Also based upon 86-62M, 84-63M and 84-64M

Note: Borings 84-62m, 84-63m and 84-64m recorded as 84-1m - 843m PAGE OF

SOIL EXPLORATION COMPANY

PROJECT Silver lake Dam DESIGNED BY ULL DATE 3-26-85
WORK ORDER NO. 120-13262 REVIEWED BY [signature] DATE 4-18-88

REVIEW COMMENTS

I. Determine ϕ'

Determination of ϕ' (from empirical formulas and graphs) based on Standard Penetration resistance ("N" values).

Boring #	Depth Ftg.	Infl. Depth	Ave N
80-13M	24'	24-34'	22
80-14M	21'	*	*
84-62m	24'	24'-26½'	27
84-63m	24'	24'-39'	17
84-64m	20'	20'-41½'	25** say 22

Ave 22 blows/ft

* Data not available - no "N" values recorded

** May be influenced by gravel in lower portion of boring

PAGE OF

SO-3.1 (82A)

SOIL EXPLORATION COMPANY

PROJECT Silver Lake Dam DESIGNED BY WLL DATE 3-26-85
WORK ORDER NO. 130-13263 REVIEWED BY [signature] DATE 4-18-85

REVIEW COMMENTS

Effective overburden while Sampling = $(18')(130) + 11'(130-62) \cong$ 3000 psf

* assuming W.T.L. e 18'

Method 1 - Gibbs and Holts presented in Meyerhof 1956 (1)

Design chart presented in Perloff + Baron "Soil Mechanics" (2) (Fig 10.20)

$\phi' = 36°$

Relative Density = 65%

Method 2 Parry (1977) (3)

$$\phi = 25 + 28(N/q)^{\frac{1}{2}} \quad \text{(where } q \text{ is in kPa)}$$
$$= 25 + 28(22/143)^{\frac{1}{2}}$$
$$\cong 36°$$

SOIL EXPLORATION COMPANY

PROJECT Silver Lake Dam DESIGNED BY WLL DATE 3-26-85

WORK ORDER NO. 120-13263 REVIEWED BY [signature] DATE 4-18-85

REVIEW COMMENTS

Method 3 - Meyerholf (1956)

$\phi = 25 + 25\,D_r$ - assume $D_r = 65\%$

$\phi = 41°$

USE $\phi' = 36°$ - probably slightly conservative

II Determine $q_{ult.}$

Determination of q_{ult} based on works from Terzaghi, Meyerhof and Hanson

Method 1 - Terzaghi + Peck (1967)

$$q_{ult} = c N_c + \gamma_o D_f N_q + 0.4 \gamma_s B N_\gamma$$

Where $c = 0$

$D_f = 2'$

$\gamma_s = \gamma_o = 130 - 62 = 68$

$N_q = 46$

$B = 16'$

$N_\gamma = 49$

$\therefore q_{ult} = 68(2)(46) + .4(68)(16)(49)$

$= 6256 + 21586$

$= \underline{\underline{27842 \text{ psf}}}$

SOIL EXPLORATION COMPANY

PROJECT Silver Lake Dam DESIGNED BY WLL DATE 3-26-85
WORK ORDER NO. 120-13263 REVIEWED BY DATE

REVIEW COMMENTS

Method 2 Meyerhof

$$q = \lambda_c d_c i_c c N_{c\,strip} + \lambda_q d_q i_q \gamma D_f N_{q\,strip} + \lambda_\gamma d_\gamma i_\gamma \frac{B'}{2} \gamma N_{\gamma\,strip}$$

where $c = 0$

$B' = B = 16'$

$L' = L = 32'$

$i_q = i_\gamma = 1$ - assume not inclined loads

λ $\lambda_q = 1 + \frac{B}{L}\left(\frac{N_{q\,sq}}{N_{q\,strip}} - 1\right) = 1.16$

$\lambda_\gamma = 1 + \frac{B}{L}\left(\frac{N_c}{N_\gamma} - 1\right) = 1.0$

$N_{q\,strip} = 35$

$N_{\gamma\,strip} = 46$

$D_f = 2$

$\gamma = 68$

$d_q = d_\gamma = 1.002$ say (1.0)

$\therefore$ $q_{ult} = (1.\ )(68)(2)(35) + (1.\ )\left(\frac{16}{2}\right)(68)(46)$

$= 5.\ + 25271$

$= \underline{30652 \text{ psf}}$

PAGE OF

SO-3 (82A)

SOIL EXPLORATION COMPANY

PROJECT ______ DESIGNED BY ______ DATE ______
WORK ORDER NO. ______ REVIEWED BY ______ DATE ______

REVIEW COMMENTS

Method 3 Hansen

$$q_{ult} = c N_c s_c d_c i_c g_c b_c + \bar{q} N_q s_q d_q i_q g_q b_q + \tfrac{1}{2} \gamma B N_\gamma s_\gamma d_\gamma i_\gamma g_\gamma b_\gamma$$

where $c = 0$

$\bar{q} = D\gamma = 63(2) = 126$

$N_q = 4$

$N_\gamma = 43$

$s_q = 1.36$

$s_\gamma = 0.8$

$d_q = 1.3$

$= g_\gamma = n_q = n_\gamma = i_q = i_\gamma = d_\gamma = 1.0$

$\therefore \; q_{ult} = (126)(40)(1.36)(1.3) + \tfrac{1}{2}(63)(36)(43)(0.8)$

$= 8911 + 17338$

$= 26249$

PAGE OF

SO 3 (82A)

SOIL EXPLORATION COMPANY

PROJECT Silver lake Dam DESIGNED BY WLL DATE 3-26-85
WORK ORDER NO. 120-13263 REVIEWED BY [signature] DATE 4-18-85

REVIEW COMMENTS

III Determine q_{all}

$q_{all} = q_{ult} / FS$

where $FS = 3.0$

$\therefore$ q_{all} = 8750 psf to 10217 psf ?

Depending on which method is chosen.

IV Factor of Saftey
Assuming P. (load) = 3500 psf

Then FS = 7.5 to 8.75

Also ϕ' as estimated could be increase to Plain Strain Conditions by either $\phi_{ps} = 1.1\,\phi$ or $\phi_{ps} = (1.1 - 0.1\,B/L)\,\phi'$

We will not calc. Plain Strain Conditions because FS is allready in the Safe Range of

SO-3.1 (82A)

PROJECT SILVER LAKE DAM DESIGNED BY WLL DATE March 13, 1985
WORK ORDER NO. 120-13263 REVIEWED BY DATE

REVIEW COMMENTS

Calculations for :

"METHOD OF Fragments".

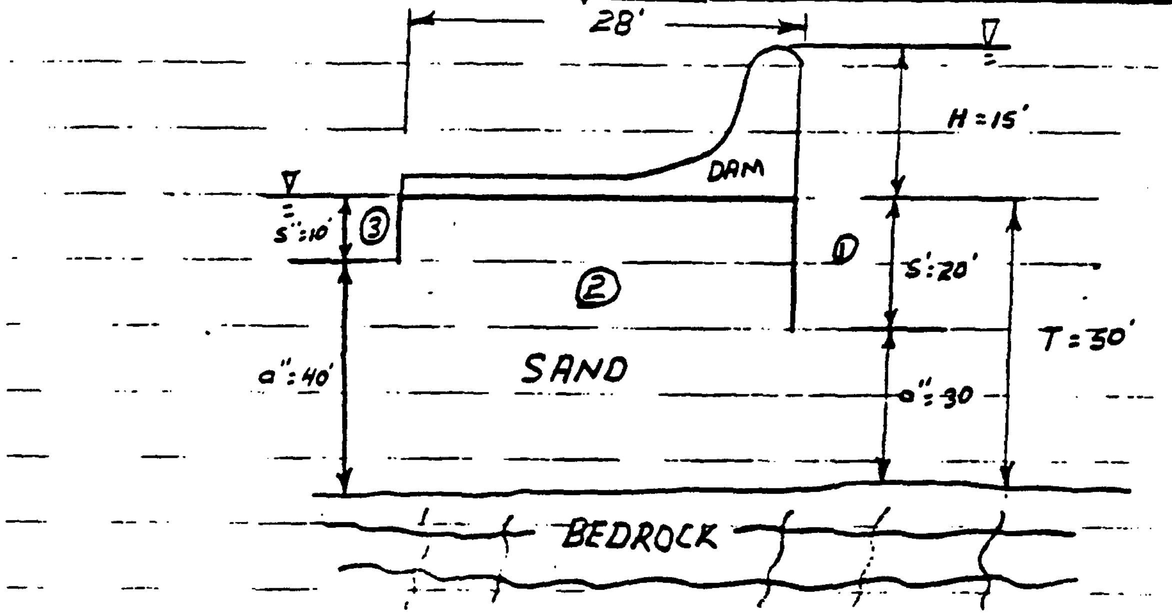
As Presented in "Mechanics of Particulate media" - Harr, M.E. (McGraw-Hill 1977) pp 158-170

All ref. of tables, graphs and assumptions are presented in the above referenced Pages. For legal & ethical reasons these tables and graphs were not re-drawn or reproduced. Copyrights forbid reproducing or transmitting these works.

PROJECT SILVER LAKE DAM DESIGNED BY W L Lawyer DATE 3-13-85
WORK ORDER NO. 120-13263 REVIEWED BY R S Dutcher DATE 3-?-85

REVIEW COMMENTS

I. Sheet Pile : 20' upstream - 10' downstream : No Apron



SECTION	TYPE	Φ	Δh
Frag ①	II	0.9	6.1'
Frag ②	VI	0.7	4.8'
Frag ③	II	0.6	4.0'
Total	—	Σ = 2.2	14.9'

CALC for Φ

Section 1 - (from fig 5-13) when b/T = 0 and S/T : 0.4

$\frac{1}{2\Phi}$: 0.58 ∴ Φ : 0.9

Section 2 when L ≤ s' + s'' Φ : ln [(1 + b'/a')(1 + b''/a'')]

where b' = [L + (s' - s'')]/2 and b'' : [L - (s' - s'')]/2

b' : 19 + b'' : 9 ∴ Φ = ln [(1.63)(1.23)] = 0.7

Section 3 (from fig 5-13) s/T = .2 Φ = 0.6

PROJECT Silver Lake Dam DESIGNED BY WLL DATE 3-13-85
WORK ORDER NO. 120-13263 REVIEWED BY R S DUTCHER DATE 3-27-85

REVIEW COMMENTS

I (con't) S' = 20', s" = 10' with no apron (Con't)

CALC. for Δh

Section 1 $\Delta h = \frac{(H)(\phi)}{\Sigma\phi} = \frac{15'(.9)}{2.2} = 6.1'$

Section 2 $\Delta h = \frac{15'(.7)}{2.2} = 4.8$

Section 3 $\Delta h = \frac{15'(.6)}{2.2} = 4.1$

CALC. for Exit Gradient

$h_m = \Delta h_{(3)} = 4.1$

using $S/T = 0.2$

from figure 5-34 we have

$I_E(S)/h_m = 0.61$

$\therefore I_E = \frac{(0.61)(4.1)}{10} = 0.25.$

$FS = 1/I_E = 1/0.244 = 4.0$

SOIL EXPLORATION COMPANY

PROJECT SILVER LAKE DAM DESIGNED BY W L Lawyer DATE 3-13-85

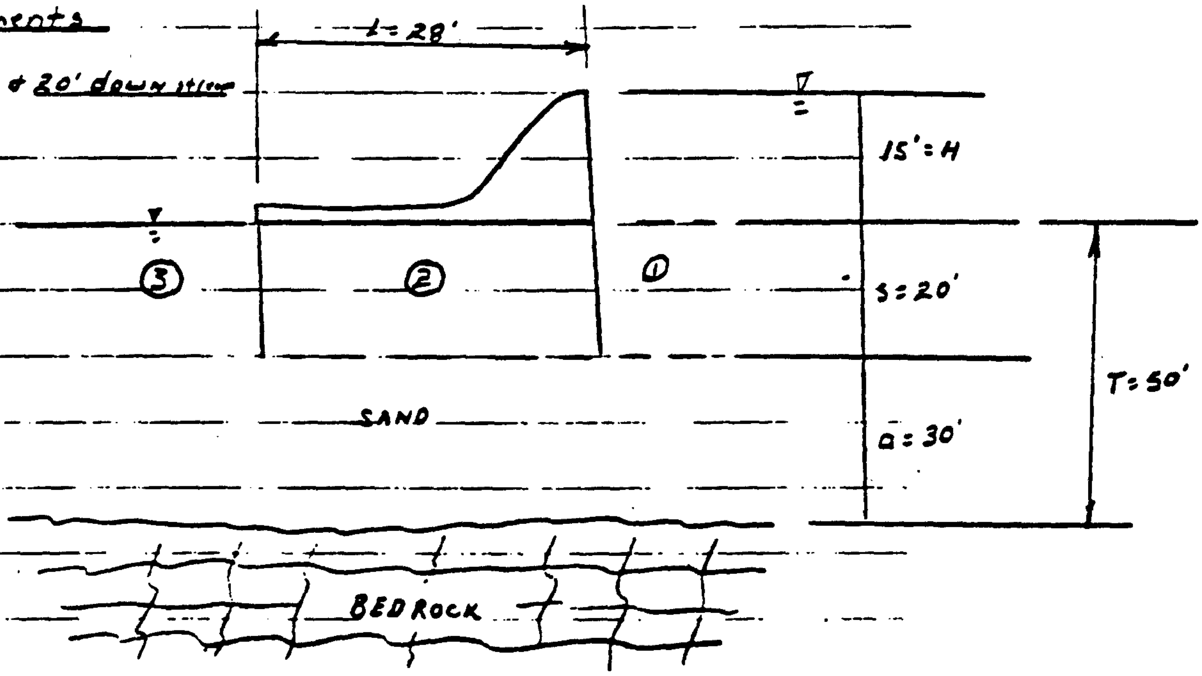
WORK ORDER NO. 120-13263 REVIEWED BY R S Dutcher DATE 3-27-85

REVIEW COMMENTS

Method of Fragments

for 20' upstream + 20' downstream

No apron



Section	Type	Φ	Δh
1	II	0.862	5.19
2	V	0.766	4.62
3	II	0.862	5.19
Total	—	2.490	15.00

CALC for Φ + Δh.

Section 1 + Section 3

Fig 5-3

b/T = 0 + s/T = .4

$\frac{1}{2\Phi}$ = .58 ∴ Φ = .862

$h = \frac{\Phi (H)}{\Phi_{Total}} = \frac{0.862 (15)}{2.490}$

= 5.19

Section 2

Where L = 28

$\Phi = 2 \ln (1 + \frac{L}{2a})$

= 0.766

$\Delta h = \frac{(0.766)(15)}{2.490}$

= 4.62

Exit Gradient

$\Delta h_{(3)} = h_m = 5.19$

with s/T = .4, from

Fig 5-34 we get

$I_E\, S / h_m = 0.6$

$\therefore I_E = \frac{(0.6)(5.19)}{20} = 0.156$

FS = 1/.156 = 6.41

say FS = 6.4

Uplift

$R = \frac{4.62}{68} \times 100 = 6.8\%$

@ Heel : 8.3 ft of Water

@ Toe = 6.2 ft of Water

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SO-33 (82A)

SOIL EXPLORATION COMPANY

PROJECT SILVER LAKE DAM DESIGNED BY W L L DATE 3-14-85

WORK ORDER NO. 120-13263 REVIEWED BY R. S. DUTCHER DATE 3-27-85

REVIEW COMMENTS

III. Sheet Pile : 25' upstream - 20' downstream - No Apron

Assume : Depth to rock ≈ 50'

$s' = 25'$ upstream ∴ $a' = 25'$

$s'' = 20'$ downstream ∴ $a'' = 30'$

No Apron

Dam Length = L = 28'

Section	Type	ϕ	Δh
Fragment 1 upstream	II	1.0	5.57
" 2 middle	VI	0.831	4.63
" 3 downstream	II	0.862	4.80
Total	–	2.693	15.00

Calc for ϕ

Section 1 - $\frac{1}{2\phi} = .5$ (where $s/T = .5$) ∴ $\phi = 1.0$

Section 2 - $\phi = \ln[(1+\frac{b'}{a'})(1+\frac{b''}{a''})]$ when $L \le s'+s''$

$b' = \frac{28+5}{2} = 16.5$ $b'' = \frac{28-5}{2} = 11.5$

$\phi = \ln[(1+\frac{16.5}{25})(1+\frac{11.5}{30})] = 0.831$

Section 3 - $s/T = .4$ ∴ $\frac{1}{2\phi} = .58$ ⇒ $\phi = 0.862$

Calc for Δh

Section 1 $\Delta h = 1.0(15)/2.693 = 5.57$

Section 2 $\Delta h = (0.831)(15)/2.693 = 4.63$

Section 3 $\Delta h = (0.862)(15)/2.693 = 4.80$

(Con't on next page)

soil exploration company

PROJECT Silverlake Dam DESIGNED BY WLL DATE 3-14-85

WORK ORDER NO. 120-13263 REVIEWED BY R S. Dutcher DATE 3-27-85

REVIEW COMMENTS

II (con't) 25' up - 20' down (con't)

calc for Exit Gradient

$S/T = 0.4$ $\therefore I_E S/h_m = 0.6$

$\therefore I_E = \frac{0.6(4.8)}{20} = \underline{0.144}$

$FS = 1/I_E = 1/.144 = \underline{6.9}$

Uplift

$R = \frac{\Delta h(2)}{\Sigma L+S'+S''} = \frac{4.63}{28+25+20} \times 100 = \underline{6.34\%}$

uplift @ heel = 15.0' - 5.57 - (.063)(25)

= 7.8' of water

@ Toe = 7.8' - (.063)(28)

= 6.1' of water

PROJECT Silver Lake Dam DESIGNED BY WLL DATE 3-14-85
WORK ORDER NO. 120-13263 REVIEWED BY R S Dutchek DATE 3-2-85

REVIEW COMMENTS

IV. Sheetpile: 25' upstream - 20' downstream - 12' apron

Assume: Depth to ROCK = 50'

Dam Length = 28'

Sheet pile Lengths driven to: upstream 25' = S' ∴ a' = 25'

downstream 20' = S'' ∴ a' = 30'

with a 12' apron

SECTION	LOCATION	TYPE	Φ	Δh
1	Upstream	III	1.04	5.71
2	Middle	VI	0.831	4.56
3	Downstream	II	0.862	4.73
Total	—	—	2.733	15.00

Calc for Φ

SECTION 1 - (Fig 5-13) where $b/T = \frac{12}{50} = .24$ and $S/T = .5$

$\frac{1}{2\Phi} = 0.48$ ∴ $\Phi = 1.04$

SECTIONS 2 & 3 - See S' = 25 & S'' = 20; No Apron (pg 4)

Calc for Δh

Section 1 (1.04)(15) / 2.733 = 5.71

Section 2 (0.831)(15) / 2.733 = 4.56

Section 3 (0.862)(15) / 2.733 = 4.73

PROJECT ______ DESIGNED BY ______ DATE 3-14-85
WORK ORDER NO. ______ REVIEWED BY R. S. DUTCHER DATE 3-27-85

REVIEW COMMENTS

IV (con't) 25' upstream - 20' downstream - 12' Apron (Con't)

Calc for Exit Gradient

$S/T = .4 \therefore$ from Fig 5-34 $I_E\, S/h_m = 0.6$

$\therefore \quad I_E = \frac{(0.6)(4.7)}{20} = \underline{0.141}$

$FS = 1/0.141 = \underline{7.1}$

Uplift

$R = \frac{\Delta h_{w}}{\Sigma \text{ distance}} = \frac{4.56}{25+28+20} = \frac{4.56}{73} \times 100 = 6.25\%$

uplift @ Heel $= 15' - 5.71 - (.0625)(25)$
$= \underline{7.7' \text{ of water}}$

@ TOE $= 7.7' - (.0625)(28)$
$= \underline{6.0' \text{ of water}}$

SC 11 (8/76)

REVIEW COMMENTS

II s' = 20' upstream ; s' = 26' downstream

No Apron

Dam Length = 28' = L ; Depth to Rock = 50' = T

a" = T - s" = 30' a' = 25'

Section	Location	Type	ϕ	Δh
1	upstream	II	0.862	4.80
2	middle	VI	0.831	4.63
3	downstream	II	1.00	5.57
			2.693	15.00

CALC. for ϕ

Section 1

USING Fig 5-13 with b/T = 0 and S/T = 0.4

$\frac{L}{2a} = .58$ $\therefore$ $\phi = .862$

Section 2

When $L \le s' + s''$ $\phi = \ln\left[\left(1+\frac{b'}{a'}\right)\left(1+\frac{b''}{a''}\right)\right]$

where $b' = [L + (s' - s'')]/2$ and $b'' = [L - (s' - s'')]/2$

$b' = 16.5$ $b'' = 11.5$ $\phi = \ln[(1.66)(1.383)]$

$\therefore \phi = 0.831$

Section 3 USING Fig 5-13 with b/T = 0 S/T = 0.6

$\phi = 1.0$

SOIL EXPLORATION COMPANY

PROJECT ____________________ DESIGNED BY ____________________ DATE 3-14-85

WORK ORDER NO. ____________________ REVIEWED BY R.S. DUTCHER DATE 3-27-85

REVIEW COMMENTS

V (con't) 20' upstream, 25' downstream

Calc for Δh

Section 1 (15 * 0.862)/2.693 = 4.80

Section 2 (15 * 0.831)/2.693 = 4.63

Section 3 (15 * 1)/(2.693) = 5.57

CALC for Exit Gradient

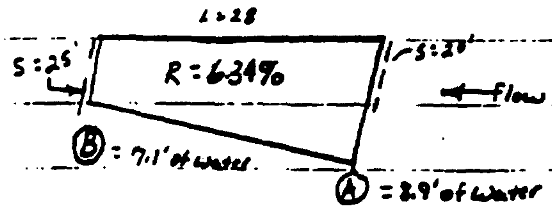
$S/T = 0.5 \therefore I_E (s)/h_m = 0.59$

$I_E = \dfrac{(0.59)(5.57)}{25} = 0.131$

$FS = 1/I_E = 1/0.131 = 7.6$

CALC for uplift

$R = [(4.63)/20+25+28]100 = 6.34\%$



A = 15 - (4.80) - (.0634 * 20)

= 8.9

B = 8.9 - (.0634 * 28)

= 7.1

soil exploration company

PROJECT ____ DESIGNED BY ____ DATE 3-14-85

WORK ORDER NO. ____ REVIEWED BY R. S. Dutcher DATE 3-27-85

REVIEW COMMENTS

VI

S = 25' - both upstream and down stream

No apron

Dam Length = L = 28' ; T = 50' (Depth to Rock)

a = 25'

Section	Location	TYPE	Φ	Δh
1	Upstream	II	1.00	5.19
2	Middle	V	0.889	4.62
3	Downstream	II	1.00	5.19
Total	—	—	2.889	15.00 (ok)

CALC for Φ

Sections 1 + 3

$b/T = 0$ $S/T = 0.5$ using fig 5-13

$\frac{1}{2\phi} = 0.5$ $\therefore$ $\phi = 1.0$

Section 2

When $L \leq 2S$

$\Phi = 2 \ln\left(1 + \frac{L}{2a}\right) = 2 \ln\left(1 + \frac{28}{50}\right)$

$\Phi = 0.889$

PROJECT ______ DESIGNED BY ______ DATE 3-14-85
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REVIEW COMMENTS

VI (con't) S = 25' with no apron (con't)

Calc for Δh

Sections 1+3 $\Delta h = (15 \times 1.0) / 2.889 = \underline{5.19}$
Section 2 $\Delta h = (15 \times 0.889) / 2.889 = \underline{4.62}$

Calc for EXIT GRADIENT

$S/T = 0.5$ ∴ Using fig 5-34
$I_E (s)/h_m = \underline{0.59}$

$$\Rightarrow I_E = \frac{(0.59)(5.19)}{25} = \underline{0.122}$$

$F_S = 1/0.122 = \underline{FS = 8.2}$

CALC for UPLIFT

$R = (4.62 / 50+28) 100 = 5.92\%$

Uplift
Upstream = $15 - 5.19 - (.0592 * 25) = \underline{8.3' \text{ of water}}$
Downstream = $8.3' - (.0592 * 28) = \underline{6.6' \text{ of water}}$

PROJECT ______ DESIGNED BY ______ DATE 3-14-85

WORK ORDER NO. ______ REVIEWED BY R. S. DUTCHER DATE 3-27-85

REVIEW COMMENTS

(Note : also see plate 3 of SEC report 120-13263)

VII Sheet Pile drive to 25' both upstream and downstream. Also a 10' apron upstream - used primarily for cover of anchors & infiltration between piles and dam wall.

Dam Length = 28'

a = 25' : T = 50'

Section	Location	TYPE	Φ	Δh
1	Upstream	III	1.04	5.33
2	middle	V	0.889	4.55
3	Downstream	II	1.00	5.12
Total	–	–	2.929	15.00

Calc for Φ

SECTION 1 using fig 5-13 with b/T : 0.20 and $S/T = 0.5 \Rightarrow \frac{1}{2\Phi} = 0.48$

$\therefore \Phi = 1.04$

SECTION 2 + 3 (see S = 25' w/ no apron calc III page 11)

$\Phi_2 = 0.889$ & $\Phi_3 = 1.00$

VII (con't) S:25' w/10' Apron (con't)

CALC for Δh $\left(\Delta h = \frac{H(\phi)}{\Sigma \Phi}\right)$

Section 1

$\Delta h = (15)(1.04)/2.929 = \underline{5.33}$

Section 2

$\Delta h = (15)(0.889)/2.929 = \underline{4.55}$

Section 3

$\Delta h = (15)(1.0)/2.929 = \underline{5.12}$

Calc for EXIT GRADIENT (I_E)

with S/T = 0.5 & fig 5-34

$\frac{I_E\ (s)}{h_m} = 0.59 \quad \therefore \quad I_E = \frac{(0.59)(5.12)}{25}$

$I_E = 0.1208$

$FS = 1/I_E = 8.3$

CALC for UPLIFT

$R = \left(4.55/25+25+28\right)100 = 5.83\%$

Uplift Upstream $= 15' - \underset{\Delta h}{5.33}$ (section 1) $- (0.0583 * 25') = \underline{8.2'\ \text{of Water}}$

downstream $= 8.2 - (0.0583 * 28') = \underline{6.6'\ \text{of Water}}$

PROJECT Silver lake Dam DESIGNED BY WLL DATE March 12, 1985
WORK ORDER NO. 120-13263 REVIEWED BY DATE

REVIEW COMMENTS

Calculations for:

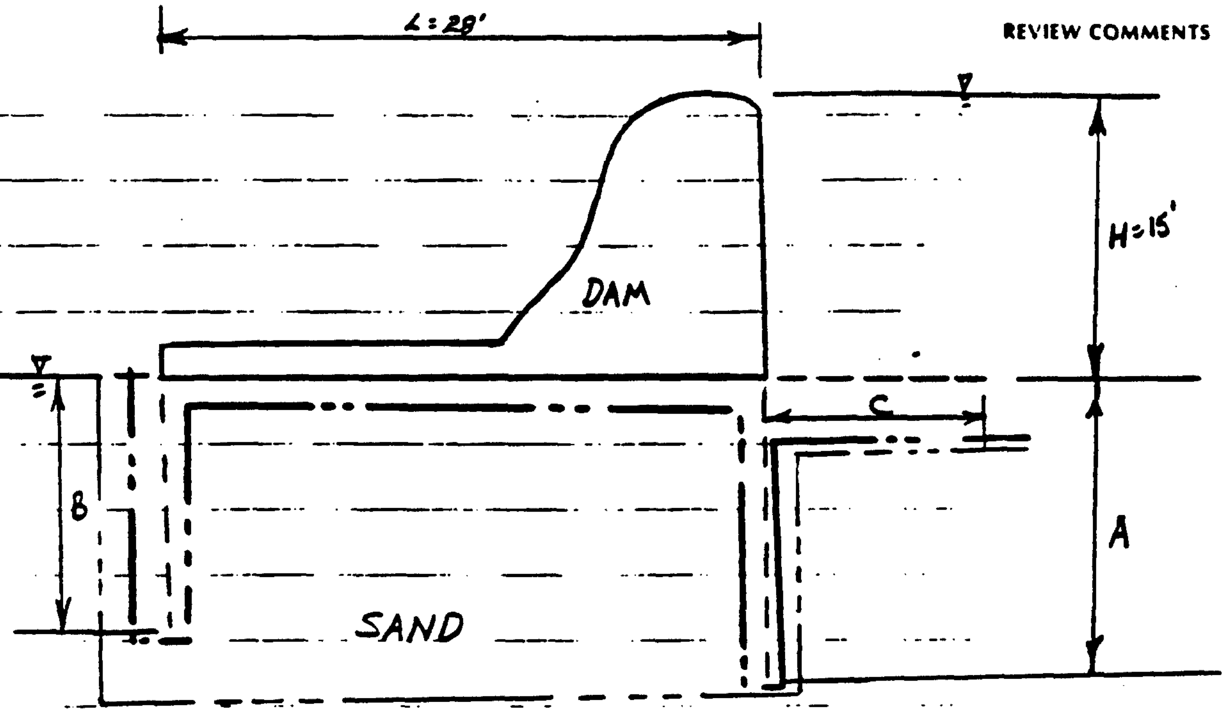
"Creep - ratio"

As presented in "Fundamentals of Soil Mechanics" - Taylor, D., (John Wiley & SONS, 1967 pp 550-555)

• All calculations based on the stated assumptions in above references.

PROJECT Silver Lake Dam DESIGNED BY WLL DATE 3-12-85
WORK ORDER NO. 120-13263 REVIEWED BY DATE

REVIEW COMMENTS



A, B & C - represented by dashed lines - will be varied and Creep ratio's VS varing "A", "B" & "C"'s tabulated.

—— - - —— Critical Path 1 LONG

—— - - - —— Critical Path 2 Short

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SOIL EXPLORATION COMPANY

PROJECT Silver Lake Dam | DESIGNED BY ULL | DATE 3-12-85
WORK ORDER NO. 120-13263 | REVIEWED BY R. S. Quitten | DATE 3-27-85

REVIEW COMMENTS

CALCULATIONS for CREEP RATIO

A	B	C	CALCULATIONS Path 1	Creep Ratio	CALCULATIONS Path 2	Creep Ratio	Safety Factor
20	10	0	$20+20+\frac{28}{3}+10+10$	69.3 *	$20+(2\times\sqrt{10^2+28^2})+10$	89.5	$\frac{69.3^*}{15}=4.6$
20	20	0	$20+20+\frac{28}{3}+20+20$	89.3 *	$20+(2\times 28)+20$	96.0	$\frac{89.3^*}{15}=5.9$
25	20	0	$25+25+\frac{28}{3}+20+20$	99.3 *	$25+(2\times\sqrt{20^2+28^2})+20$	109.0	$\frac{99.3^*}{15}=6.6$
25	20	12	$\frac{12}{3}+25+25+\frac{28}{3}+20+20$	103.3 *	$\frac{12}{3}+109$ (above)	113.0	$\frac{103.3}{15}=6.9$
20	25	0	Same as 25-20-0	99.3 *	Same as 25-20-0	109.0	6.6
25	25	0	$25+25+\frac{28}{3}+25+25$	109.3	$25+(2\times 28)+25$	106 *	$106/15=7.1$
25	25	10	Same as above $+\frac{10}{3}$ $=109.3+10/3$	112.6	Same as above $+\frac{10}{3}$ $=106+10/3$	109.3 *	$\frac{109.3}{15}=7.3$

* INDICATES Critical Path

APPENDIX C

STRUCTURAL ANALYSIS AND DESIGN

FLOOD CONTROL
SOUTH FORK ZUMBRO RIVER
FEATURE DESIGN MEMORANDUM
ROCHESTER, MINNESOTA, STAGE 1-B
APPENDIX C

STRUCTURAL ANALYSIS & DESIGN

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APPENDIX C

STRUCTURAL ANALYSIS & DESIGN

PURPOSE

1. This appendix describes the methodology and assumptions used in the analysis and/or design of:

   (a) Modifications to Silver Lake Dam

   (b) Flood/Retaining Walls

   (c) Bikeway Underpass Structures

REFERENCES

2. The applicable sections of the following references were used to formulate design criteria and to determine allowable stresses in the various structural components.

(a)	EM 1110-1-2101	Working Stresses for Structural Design (November, 1963)
(b)	EM 1110-2-2103	Details of Reinforcement-Hydraulic Structures (May, 1971)
(c)	EM 1110-2-2906	Design of Pile Structures and Foundations (July, 1958)
(d)	ETL 1110-2-256	Sliding Stability for Concrete Structures (June, 1981)
(e)	EM 1110-2-2200	Gravity Dam Design (Sept., 1958)
(f)	ETL 1110-2-275	Concrete Removal Methods (July, 1982)
(g)	ETL 1110-3-338	Wind and Snow Loads (February, 1983)
(h)	EM 1110-2-2702	Design of Spillway Tainter Gates (August, 1966)
(i)	EM 1110-2-2002	Maintenance and Repair of Concrete and Concrete Structures (March, 1979)
(j)	EM 1110-2-2000	Standard Practices for Concrete (Sept., 1982)

(k) EM 1110-2-XXXX Retaining and Flood Walls (June 14, 1985)

(l) EM 1110-2-1612 Ice Engineering (Oct., 1982)

(m) Condition Survey, Silver Lake Dam, Rochester, MN. Barrientos & Assoc., Inc. (January, 1985)

(n) Specifications for Dam Repair - Silver Lake Dam, Harza Engineering Co., (May, 1982)

(o) Construction Summary Report - Silver Lake Dam Repair, Harza Engineering Co., (November, 1981)

(p) Specifications for Dam Repair - Silver Lake Dam, Harza Engineering Co., (July, 1981)

(q) Repairs to Silver Lake Dam, Harza Engineering Co., (January, 1952)

(r) Stell Construction Manuai (AISC 8th Edition)

(s) Building Code Requirements for Reinforced Concrete (ACI 318-83)

(t) American Association of State Highway and Transportation Officials Standard Specifications for Highway Bridges 1983, as Amended by 1984 and 1985 Interim Specifications

DESIGN CRITERIA

REINFORCED CONCRETE STRUCTURES

3. The modifications and additions to the concrete elements of the existing Silver Lake Dam were designed in accordance with Working Stress Design (WSD). A concrete compressive stress (f'c) of 3000 pounds per square inch (psi) was used in the design of the alterations. Actual compressive concrete fiber stress was held to 1050 psi as per hydraulic structures requirements. Maximum reinforcing steel stress was limited to 20,000 psi in deformed billet steel bars of Grade 40 or better.

4. The reinforced concrete flood/retaining walls, abutment wing wall extensions, bikeway retaining walls and bridges were designed in accordance with the principles of Load Factor Design. Ultimate concrete compressive strength (f'c) of 4000 psi was used for design. Maximum reinforcing steel stress was limited to 48,000 psi in deformed billet steel bars of Grade 40 or better.

STRUCTURAL STEEL

5. The modifications to the existing tainter gates and the new Pier No. 3 access bridge were designed in accordance with EM 1110-1-2101 using a basic working stress 18,000 psi. Structural steel shall conform to ASTM A36.

STEEL SHEET PILING

6. Steel sheet piling shall conform to the requirements of ASTM A328. The maximum allowable stress shall be 23,500 psi.

ALUMINUM

7. Aluminum required for miscellaneous elements shall be 6061-T6. Working stresses used in the designs will be in accordance with EM-1110-1-2101

TREATED TIMBER PILING

8. Where new piling were added, such piling were designed for a maximum loading of 20 tons per pile. The timber piles and treatment shall conform to Guide Specification CE 1304.03.

STEEL H PILING

9. Bike path bridge abutment piling were designed for a maximum loading of 40 tons per pile. The steel H piling shall conform to Guide Specification CE 1304.02.

STRUCTURAL TIMBER

10. The timber used in the roofs of the mechanical rooms at Silver Lake Dam shall be Douglas Fir Dense No. 1 grade or better per the Western Wood Products Association.

UNIT WEIGHTS

11. The unit weights used in design were assumed as follows:

Concrete	150	P.C.F.
Steel	490	P.C.F.
Water	62.4	P.C.F.
Earth (Silver Lake Dam)	120	P.C.F.
Earth (Sat) Flood Walls	125	P.C.F.
Earth (Sub.) Flood Walls	65	P.C.F.
Timber	40	P.C.F.
Soil (Immersed)	80	P.C.F.

ICE LOADING

12. The ice loading used in the structural design of Silver Lake Dam modification was assumed 1000 pounds per linear foot of loaded structure applied at the critical horizontal ice plane. This value was established in conference with local officials of the Corps of Engineers.

DEPTH OF COVER

13. Any additions to the existing foundations at Silver Lake Dam were set at the depth of such foundations. Therefore, it is expected that frost cover will be satisfactory. Footings for retaining walls shall be founded on sound rock capable of resisting the design loads or on soil with a minimum frost cover of 5'-0".

DESIGN OF STRUCTURES

GENERAL

14. The modifications to be made to Silver Lake Dam were of superficial structural nature only, so far as the total dam was concerned. The added dead loads and live loads from the eqiupment houses were relatively small, the raise of head of water on the dam was nominal, and the change to a hinged leaf gate of local effects only. Thus, the major design effort there became the proving of the existing structure as satisfactory and/or correcting its deficiencies.

15. The bikeway underpass at the east abutment of the Center Street Bridge was designed in detail. Appropriate items therefrom were used to estimate the quantities for bikeway underpasses at Seventh Street and Third Avenue.

SILVER LAKE DAM

OGEE - STILLING BASIN

16. The existing ogee - stilling basin was analyzed as it would function with the concrete ogee cut away to seat the new hinged leaf gate. The analysis was performed using dead load; full water pressure, uplift, and silt (earth) pressures; and ice load applied at the top of the gate. It was found that the ogee - stilling basin was stable against overturning in that its piling were not overloaded in vertical loading. However, the piles could not resist the sliding forces in direct shear.

17. To remedy this, forces were introduced into the ogee - stilling basin through the use of soil anchors. Such forces were set to act opposite to those of the sliding forces. With 30 ton soil anchors working at 7'-0" spacing, the structure proves satisfactory in both stability and sliding.

18. An upstream widening of the ogee - stilling basin was required to fit the hinged-leaf gate's upstream shape to the new ogee's downstream curve. The details of the widening are shown on the structural plates. The concrete-wall type widening was designed to take the horizontal and vertical reactions of the gate as brought about by bearings acting at 15 foot centers.

EQUIPMENT HOUSE AT RIGHT ABUTMENT

19. To provide for a house large enough to suit the equipment, it was necessary to locate the house limits seven feet upstream from the existing abutment face. This modification was made in mass concrete founded on a new pile - supported footing. It was felt that this construction would prove most economical in long-term maintenance.

20. An analysis was run of the modified structure as founded on its pile pattern. The analysis showed the existing abutment piles to be significantly overloaded in vertical loads. Over thirteen additional piles would be necessary to make the abutment figure theoretically adequate yet the existing abutment has stood for 50 years with nearly the same loading and shows no distress.

21. A second analysis was run of the modified structure as though founded on supporting soils. The maximum soils pressures developed under the governing loading was 3.5 kips per square foot. Soils Exploration, Inc. has analyzed the supporting soils as capable of taking this load with a safety factor of seven. This probably means that the existing overstressed piles must be yielding slightly allowing the more than adequate soils below to come into bearing.

22. The floor of the house was designed to transfer a 140 kip trunnion loading, yielding components of 125 kips vertically and 65 kips horizontally, into the foundations below.

MODIFICATIONS AT LEFT ABUTMENT

23. Assuming the yielding of the foundation piles in the left abutment under design loads, the soils below come into bearing and successfully support the structure. Thus, no modifications prove necessary at the left abutment other than those minor constructions to seat the new access bridge running to Pier No. 3.

MODIFICATION TO TAINTER GATE PIERS NO. 1 AND NO. 2

24. An analysis of the tainter gate piers under the existing loads show them to be in danger of sliding if dependent on the shearing resistance of their piles alone.

25. To remedy this, forces were introduced into the tainter gate bays through the use of soil anchors. Such forces were set to act opposite to those of

the sliding forces. With 25 ton soil anchors working at 7'-0" spacing, the structure proves satisfactory in both stability and sliding. Additional minor construction is required to seat the new access bridge.

EQUIPMENT HOUSE AT TAINTER GATE PIER NO. 3

26. As per the right abutment, the tainter gate Pier No. 3 was made large enough to suit equipment needs by widening and extending the pier mass upstream. New pile supported footings were provided for the widening and lengthening.

27. An analysis was run of the modified structure as founded on its new pile pattern. The analysis indicated the structure was satisfactory in the vertical loadings of the piling but deficient in its resistance to sliding through shear in the piles.

28. As per Pier No. 1 and No. 2., 25 ton soil anchors working at 7'-0" spacing were used to introduce forces opposite to the sliding forces. The analysis then proved satisfactory.

STRENGTHENING OF TAINTER GATES

29. The existing tainter gates were analyzed assuming the use of ASTM A-7 steel stresses of 16,500 psi (with 33% overstress of 22,000 psi when in combination with ice). The make up of the gates was taken from the Condition Survey as prepared by Barrientos & Associates, Inc.

30. The gate was analyzed in two "down" positions for maximum water load plus ice. The initial position was with the gate's lower edge resting on its seal. The second position was with the gate lifted by its chains to raise its lower edge just off of the seal. The gate frame was run on the computer as fully continuous as per welded joint theory.

31. The check of all existing members in the gate frame under governing stress indicated an overstress in the most upstream vertical 6" x 4" x 3/8" angle. A method of strengthening the angle was developed and appears on the structural drawings. This member was the only part of the gate deficient in strength.

NEW ACCESS BRIDGE

32. A new access bridge was designed to serve the new equipment house at tainter gate Pier No. 3. The bridge was repositioned from its original location so that the tainter gate underneath could be opened fully without fouling the structure. The bridge was designed for 100 psf uniform pedestrian live load plus concentrated loads at fixed locations brought on to the bridge by the tainter gate's lifting chains.

33. The bridge was designed in structural steel per ASTM A36. It was felt that steel would be the most suitable median for erection over the operating tainter bays. A galvanized bar grating deck was designed with the intent that the final grating closures be placed in the deck after the final positioning of the chain hoists to suit the travel of the lifting chains.

NEW UPSTREAM APRON AND CONCRETE REPAIRS

34. The new upstream apron's width was set by the seepage analysis as run by Soils Exploration, Inc., the soils consultant to the project. The apron's design was based on empirical standards successfully in use.

35. The concrete repairs as illustrated in the structural plates, may not be all of those needed. After the dewatering of the structure is accomplished, a thorough inspection of the structure in the dry should be made. Such additional repairs as prove necessary should be performed on a "force-account" basis.

PRESSURE GROUTING

36. The dam has had some pressure grouting of its foundation done in past years.

37. In 1952, a recommendation was made by Harza Engineerng Company to grout under the entire length of ogee section. Apparently this was not done entirely. Borings taken by Barrientos & Associates, Inc. during their Condition Survey of January, 1985, found no grout to the right of the mid-length of ogee.

38. In 1981, while repairing the dam, an undermining of the tainter gate area was discovered. Repairs were made, in a contract of May, 1982, by the driving of sheet piling about the upstream face of the tainter gate apron, and by the pressure grouting of major voids under the entire gated portion.

39. Barrientos' Condition Survey of January, 1985, indicates an apparent void under the ogee portion of the structure approximately 10 foot to the right of the tainter gate Pier No. 3. However, it would appear that there is no significant seepage through this void.

40. No pressure grouting of the void or voids is felt necessary as part of the recommended modifications. The new seepage control as shown on the structural plates should prove very effective.

CONCRETE REMOVAL METHODS

41. Those cuts of concrete section requiring straight line exposed edges shall have such edges cut to a depth of one inch minimum with a diamond saw or approved substitute, prior to use of breaker equipment for deeper removal.

42. Explosive blasting will be permitted for the removal of the mass ogee concrete, but only after satisfying all permit requirements as required by the City of Rochester. A fully developed blasting plan shall be presented to the Corps of Engineers and other interested authorities at least 10 days in advance of such blasting. Such plan shall list methods of blasting; experience of personnel performing blasting; safety precautions that will be used in protecting life, property, and the environment; methods of explosive storage; and anticipated time and dates of blasting. The Contractor shall make arrangements of the control of vehicular and pedestrian traffic as might be necessary at the time of blasting.

43. In lieu of explosive blasting, a vehicle mounted breaker may be used to remove the mass concrete of the ogee, but the energy output shall be monitored to preclude damage to the remaining concrete.

FLOOD/RETAINING WALLS

LOCATION

44. The concrete flood/retaining wall is located on the right bank from stations 125+73 to 126+58 and on the left bank from stations 126+23 to 126+50. This is between the Silver Lake Dam and the North Broadway bridge.

DESIGN LOADS

45. Soil parameters used were determined from lab tests of soil samples near the walls. The saturated unit weight of soil used was 125 p.c.f., internal friction angle equal to 35°, and wall friction equal to 12°. The critical design case these walls were designed for was saturated soil behind the walls to EL. 978.88 with a sloping backfill. Sliding was computed using a strength reduction factor (SRF) of 2/3 to withstand the horizontal forces. A load factor of 1.9 was applied to the live and dead load. The maximum bearing pressure on the wall foundation was 3.0 k.s.f.

SEVENTH STREET BRIDGE WINGWALL EXTENSIONS

46. Cantilever sheet pile wing wall extensions with a concrete cap are required on both abutments of the Seventh Street bridge. The top elevation of the wing walls is approximately elevation 981.1 plus or minus, and varies in length from 27 to 35 feet. A level backfill extended 1/3 of the embankment height above the wall height was used because of an embankment slope of 30°. An adjusted internal friction angle (0 adj) with a safety factor of 1.5 and a wall friction angle of 8° (½0 adj/3) used to determine piling length. The design reference was the USS Steel Sheet Piling Design Manual with the above exceptions.

LOCATION

47. The flood/retaining wall is located on the right bank from Sta. 169+40 to 174+79 adjacent to an existing cemetery access road. A sanitary sewer and bike path shall be located between the wall and the cemetery road.

DESIGN LOADS

48. The upper two feet of existing rock is considered unsuitable to support structures. For wall design, the level badkfill was assumed cohesionless and fully submerged. The internal friction angle used was 32^{o}. A live load surcharge of two feet of earth was applied to account for possible maintenance vehicles on the bikeway. Sliding was computed (SRF = 2/3) and a key was designed in the rock to withstand the excess horizontal forces. Maximum allowable bearing pressure on sound rock was assumed to be five tons per square foot. Maximum design bearing pressure was 3.1 tons per sq. ft. with no uplift permitted at the heel for any load combination. For design of steel reinforcing a load factor of 1.9 was applied to dead load plus live load.

49. Three cases of loading were considered as follows:

Case I: Dead load plus dry backfill at 55 pounds equivalent fluid pressure (EFP) plus live load surcharge.

Case II: Dead load plus submerged backfill at 98 pounds EFP.

Case III: Dead load plus a 30 PSF wind on the front face of wall. This loading primarily used to assure that front face reinforcing is adequate to withstand wind loads prior to placement of backfill.

LOCATION

50. The sheet pile flood wall with a concrete cap is located on the left bank from stations 172+37 to 182+60 and from stations 184+75 to 186+25.

DESIGN LOADS

51. Soil parameters usesd were determined from lab tests of soil samples near the wall. The design reference used for this anchor-sheet pile wall was the USS Steel Sheet Piling Design Manual with the following exceptions. An adjusted internal friction angle (0 adj) with a safety factor of 1.5 was used in the determination of the piling length, but not to the piling section modulus sizing. A level backfill to the top of the wall was assumed with a wall friction angle of 8^{o} (X0 adj/3). The saturated unit weight of soil used was 125 p.c.f.. A 2" diameter tie-rod of A36 steel was used with a 9 ' and 12' spacing. A continuous concrete anchor deadman was used in the region of full mobilization. The wales are A36 structural steel channels.

LOCATION AND CONDITION COMMENTS

52. The existing flood wall on the left bank from approximately Sta. 202.90 to Sta. 205 was analyzed using EFP of 98 PCF. At upstream end of wall where fill is to top of wall the reinforcing steel is overstressed and resistance to lateral forces is inadequate. At the downstream end of the wall the fill is about four feet below the top of wall however, horizontal pile shears are excessive.

53. If the stream bed is lowered as planned it is likely that the lateral deflections will increase and the piles will become overstressed in bending as well as shear.

CENTER STREET BIKEWAY UNDERPASS

EXISTING EAST ABUTMENT MODIFICATIONS

54. The elevation of the bottom of the proposed new channel is approximately four feet lower than the bottom of footing of the east abutment of the Center Street Bridge. Since scour protection is required for this footing it was economical to combine the design of the bikeway with the scour protection in front of the abutment.

55. Using a strength reduction factor (SRF) of 2/3 the abutment was checked for sliding under dead load plus submerged earth to the elevation to design high water plus live load surcharge. Drilled-in rock anchors were designed to withstand the residual horizontal forces not counteracted by friction.

BIKEWAY BRIDGES

56. Since the design live load for a bikeway is only 85 PSF it is possible to construct a continuous three-span concrete slab bridge at each side of the abutment more economically than to use retaining walls. The piers and abutments should be constructed first and the rock fill on the upstream side and riprap on the downstream side placed prior to constructing the concrete slab spans.

57. The concrete slab spans are not considered to be hydraulic structures and load factors used in accordance with ACI (1.4 DL + 1.7 LL) for design of the steel reinforcing.

58. The piers were designed with a safety factor of 1.6 against overturning with a 50 PSF wind without any superstructure dead load or backfill on the footing. Thermal forces were included in the design but wind forces on the completed structure were found to be insignificant.

BIKEWAY RETAINING WALLS

59. The retaining walls at the upper ends of the bikeway bridges have footing elevations which are above the level of design high water. The

footings for the upstream walls are founded on rock fill and the downstream footings are on soil. These walls should be isolated from the adjacent bridge abutments with expansion joint material.

60. These walls and footings were designed for two cases of loading as follows:

Case I: Dead load plus normal earth plus live load.

Case II: Dead load plus submerged earth.

Case II governed the design in all wall heights. SRF used was 2/3. Equivalent fluid pressure for normal earth was 55 PCF and for submerged earth 96 PCF. A key was designed to resist horizontal forces in excess of the friction value of the footing. Buoyancy was not considered in design of these walls since the bottom of footings are above design high water level. Maximum toe pressure is 1900 PSF and no uplift is present under the footings. A load factor of 1.9 was used for design of all reinforcing steel.

ABUTMENT WINGWALL EXTENSIONS

61. The abutment wingwall extensions are to be constructed on rock except for the 68 foot section at the downstream end of the downstream extension which will be founded on soil. These walls were designed for dead load plus submerged backfill without any live load surcharge. Sliding was computed and a key designed to resist all excess horizontal forces. A load factor of 1.9 was used for steel reinforcing design. EFP for submerged backfill was 96 PCF. Walls less than fifteen feet in height shall be 1'-0" thick at the top and higher walls shall be 1'-6" thick at the top. Back face batter for all walls is 3/4" per foot. These walls will be isolated from the bikeway bridge and pavement slabs with expansion joint material. A steel pedestrian railing similar to that existing will be required on top of the wing wall extensions.

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B

APPENDIX D
DETAILED ESTIMATE OF FIRST COST

SUMMARY OF ESTIMATED FIRST COST
(December, 1986 Price Levels)
For
Rochester Stage 1B
Feature Design Memorandum

Construction First Costs

2.3	Utility Relocation		$ 174,450.40
8.3	Bridges		
	Scour Protections		1,316,000.00
9	Channel		
	Preliminary Work	$ 56,350.00	
	Flood and Wing Walls	2,860,000.00	
	Removals	37,938.50	
	Channel Work	2,525,381.83	
	Outlet Modifications	47,500.00	
	Miscellaneous Structures	32,200.00	
	Drainage Facility	4,970.00	
	Silver lake Dam Modification	2,044,000.00	
	Restoration of Streets, Roads, Parking Lots and Sidewalks	87,944.76	
	Restoration of Railroad	21,401.50	
			7,717,686.59
14	Recreation Facilities (50% of Cost)		177,487.15
30	Engineering and Design	12% of Direct Costs	1,126,275.86
31	Supervision and Administration		
	Supervision and Inspection	4.5% of Direct Costs	422,400.00
	Overhead		348,700.00

TOTAL CONSTRUCTION FIRST COSTS..............$11,283,000.00

NON-FEDERAL FIRST COSTS

1	Lands	$ 403,000.00
2.3	Utility Relocations	342,394.68
9	Channel	
	Removal	2,300.00
14	Recreation Facilities (50% of Cost)	177,487.15

TOTAL NON-FEDERAL FIRST COSTS..........$ 925,181.83
(Not Including Cash Contribution)

TOTAL ESTIMATED PROJECT COST...........$12,208,181.83

APPENDIX D

DETAILED ESTIMATE OF FIRST COST
(December 1986 Price Levels)

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
2.3 Utility Relocation				
8" & 10" Sanitary Sewer Inverted Siphons, Sta. 156+30				
Remove 8" and 10" C.I.P. Inverted Siphons	Job	Sum	$ -	$ 5,500.00
Trench Excavation	C.Y.	6,825	5.00	34,125.00
Backfill	C.Y.	4,988	3.00	14,964.00
Backfill, Granular	C.Y.	2,988	6.50	19,422.00
8" D.I. Pipe w/Mechanical Joint	L.F.	120	18.00	2,160.00
10" D.I. Pipe w/Mechanical Joint	L.F.	120	20.00	2,400.00
8" D.I. Pipe w/Ball Joint, River Crossing	L.F.	325	105.00	34,125.00
10" D.I. Pipe w/Ball Joint, River Crossing	L.F.	325	120.00	39,000.00
Contingencies	15 Percent			22,754.40
Total 2.3 Utility Relocation................$				174,450.40
8.3 Bridges				
Bridge Scour Protections				
N. Broadway Bridge, Sta. 125+60				
Excavation, Common	C.Y.	1,120	$ 3.00	$ 3,360.00
Gabions, Type A	C.Y.	784	85.00	66,640.00
Bedding for Gabions	C.Y.	233	12.50	2,912.50
Concrete Protection				
Concrete	C.Y.	103	170.00	17,510.00
Reinforcing Steel	Lbs.	14,486	0.40	5,794.40
Cement	Cwt.	735	5.00	3,675.00
Drilling for Dowels	L.F.	188	3.00	564.00
Dowels	Lbs.	563	2.00	1,126.00
7th St. NE Bridge, Sta. 157 + 00				
Excavation, Common	C.Y.	3,736	3.00	11,208.00
Riprap, Type B	C.Y.	2,012	21.00	42,252.00
Bedding for Riprap	C.Y.	1,150	12.50	14,375.00
Concrete Protection				
Concrete	C.Y.	574	170.00	97,580.00
Reinforcing Steel	Lbs.	80,423	0.40	32,169.20
Cement	Cwt.	4,079	5.00	20,395.00
Drilling for Dowels	L.F.	176	3.00	528.00
Dowels	Lbs.	527	2.00	1,054.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
8.3 Bridges				
Bridge Scour Protections (Cont'd.)				
Dakota, Minnesota & Eastern Railroad Bridge, Sta. 174 + 25				
Excavation, Common	C.Y.	2,113	$ 3.00	$ 6,339.00
Gabions, Type A	C.Y.	1,284	85.00	109,140.00
Bedding for Gabions	C.Y.	548	12.50	6,850.00
Concrete Protection				
Concrete	C.Y.	281	170.00	47,770.00
Reinforcing Steel	Lbs.	39,358	0.40	15,743.20
Cement	Cwt.	1,996	5.00	9,980.00
Drilling for Dowels	L.F.	206	3.00	618.00
Dowels	Lbs.	596	2.00	1,192.00
Center Street Bridge, Sta. 184 + 80				
Excavation, Common	C.Y.	2,700	$ 3.00	$ 8,100.00
Excavation, Rock	C.Y.	282	10.00	2,820.00
Gabions, Type A	C.Y.	1,719	85.00	146,115.00
Bedding for Gabions	C.Y.	759	12.50	9,487.50
Concrete Protection				
Concrete	C.Y.	503	170.00	85,510.00
Reinforcing Steel	Lbs.	70,434	0.40	28,173.60
Cement	Cwt.	3,572	5.00	17,860.00
Drilling for Dowels & Rock Anchors	L.F.	438	3.00	1,314.00
Dowels	Lbs.	714	2.00	1,428.00
40K Double Erosion Protection Rock Anchors	Lbs.	490	3.00	1,470.00
3rd Avenue SE Bridge, Sta. 205 + 67				
Excavation, Common	C.Y.	1,548	3.00	4,644.00
Riprap, Type B	C.Y.	1,032	85.00	87,720.00
Bedding for Riprap	C.Y.	516	12.50	6,450.00
4th Street SE Bridge, Sta. 6 + 55				
Excavation, Common	C.Y.	1,890	3.00	5,670.00
Gabions, Type A	C.Y.	1,260	85.00	107,100.00
Bedding for Gabions	C.Y.	630	12.50	7,875.00
Dewatering	Job	Sum		104,000.00
Contingencies	15 Percent			171,487.60
Total 8.3 Bridges				$ 1,316,000.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9 Channel				
Preliminary Work				
Preparation of Disposal Areas	Job	Sum	$ -	$ 20,000.00
Clearing and Grubbing in Disposal Areas	Acre	2	2,000.00	4,000.00
Preparation for Seeding	Job	Sum	-	8,000.00
Seeding, Fertilizing, Mulching in Disposal Areas	Acre	10	700.00	7,000.00
Landscaping in Disposal Areas	Job	Sum	-	10,000.00
Contingencies	15 Percent			7,350.00
	Total Preliminary Work			$ 56,350.00
Flood and Wing Walls				
Concrete Flood Wall, Sta. 125+73 to Sta. 126+58 Rt. Bank				
Foundation Work				
Clearing and Grubbing	Acre	0.1	$ 2,000.00	$ 200.00
Stripping	C.Y.	28	2.00	56.00
Excavation, Structure	C.Y.	2,759	6.00	16,554.00
Backfill	C.Y.	3,090	3.00	9,270.00
Wall Construction				
Concrete	C.Y.	289	170.00	49,130.00
Reinforcing Steel	Lbs.	43,350	0.40	17,340.00
Cement	Cwt.	2,052	5.00	10,260.00
Joint Filler	L.F.	15	2.00	30.00
Concrete Slope Paving				
Concrete	C.Y.	117	115.00	13,455.00
Cement	Cwt.	827	5.00	4,135.00
Joint Filler	L.F.	200	2.00	400.00
Topsoil	C.Y.	25	6.00	150.00
Sod	S.Y.	590	1.30	767.00
Concrete Flood Wall, Sta. 126+23 to Sta. 126+50 Lt. Bank				
Foundation Work				
Stripping	C.Y.	30	$ 2.00	$ 60.00
Excavation, Structure	C.Y.	1,520	6.00	9,120.00
Backfill	C.Y.	1,570	3.00	4,710.00
Wall Construction				
Concrete	C.Y.	223	170.00	37,910.00
Reinforcing Steel	Lbs.	33,500	0.40	13,400.00
Cement	Cwt.	1,583	5.00	7,915.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9 Channel				
Flood and Wing Walls				
Concrete Flood Wall, Sta. 126+23 to Sta. 126+58 Lt. Bank (Cont'd.)				
Remove and Reinstall Pipe Rail	L.F.	22	$ 6.00	$ 132.00
Remove Rail & Replace with Chainlink Fence	L.F.	26	10.00	260.00
Concrete Slope Paving				
Concrete	C.Y.	42	115.00	4,830.00
Cement	Cwt.	298	5.00	1,490.00
Joint Filler	L.F	160	2.00	320.00
Topsoil	C.Y.	31	6.00	186.00
Sod	S.Y.	190	1.30	247.00
Concrete Flood Wall, Sta. 169+40 to Sta. 174+79 Rt. Bank				
Foundation Work				
Stripping	C.Y.	206	$ 2.00	$ 412.00
Excavation, Structure	C.Y.	3,041	6.00	18,246.00
Excavation, Rock	C.Y.	1,402	25.00	35,050.00
Backfill	C.Y.	5,897	3.00	17,691.00
Backfill, Granular	C.Y.	620	9.00	5,580.00
Wall Construction				
Concrete	C.Y.	1,064	170.00	180,880.00
Reinforcing Steel	Lbs.	171,800	0.40	68,720.00
Cement	Cwt.	7,555	5.00	37,775.00
Joint Filler	L.F.	120	2.00	240.00
Chainlink Fence	L.F.	460	8.00	3,680.00
Wall Toe Drain				
8" Perforated C.M. Pipe	L.F.	475	9.00	4,275.00
Flap Gates for 8" Pipe	Each	5	160.00	800.00
Storm Sewer Outlet				
Catch Basin	Each	1	1,000.00	1,000.00
24" R.C.P.	L.F.	10	29.00	290.00
Flap Gate for 24" Pipe	Each	1	450.00	450.00
Concrete Wing Wall, Sta. 182+70 to Sta. 184+76 Rt. Bank				
Foundation Work				
Excavation, Structure	C.Y.	1,759	$ 6.00	$ 10,554.00
Excavation, Rock	C.Y.	418	25.00	10,450.00
Backfill	C.Y.	1,815	3.00	5,445.00
Backfill, Granular	C.Y.	200	9.00	1,800.00
Wall Construction				
Concrete	C.Y.	528	170.00	89,760.00
Reinforcing Steel	Lbs.	79,200	0.40	31,680.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9. Channel				
Flood and Wing Walls				
Concrete Wing Wall, Sta. 182+70 to Sta. 184+76 Rt. Bank (Cont'd.)				
Cement	Cwt.	3,749	$ 5.00	$ 18,745.00
Joint Filler	L.F.	20	2.00	40.00
Handrail	L.F.	207	35.00	7,245.00
Wall Toe Drain				
8" Perforated C.M. Pipe	L.F.	206	9.00	1,854.00
Flap Gate for 8" Pipe	Each	2	160.00	320.00
Topsoil	C.Y.	52	6.00	312.00
Sod	S.Y.	472	1.30	613.60
Concrete Wing Wall, Sta. 185+93 to Sta. 186+53 Rt. Bank				
Foundation Work				
Stripping	C.Y.	39	$ 2.00	$ 78.00
Excavation, Structure	C.Y.	502	6.00	3,012.00
Excavation, Rock	C.Y.	140	25.00	3,500.00
Backfill	C.Y.	585	3.00	1,755.00
Backfill, Granular	C.Y.	43	9.00	387.00
Wall Construction				
Concrete	C.Y.	162	170.00	27,540.00
Reinforcing Steel	Lbs.	24,300	0.40	9,720.00
Cement	Cwt.	1,150	5.00	5,750.00
Handrail	L.F.	63	35.00	2,205.00
Wall Toe Drain				
8" Perforated C.M. Pipe	L.F.	104	9.00	936.00
Flap Gate for 8" Pipe	Each	1	160.00	160.00
Topsoil	C.Y.	26	6.00	156.00
Sod	S.Y.	233	1.30	302.90
Concrete Flood Wall, Sta. 202+90 to Sta. 204+97 Lt. Bank				
Foundation Work				
Stripping	C.Y.	204	$ 2.00	$ 408.00
Excavation, Structure	C.Y.	6,064	6.00	36,384.00
Backfill	C.Y.	6,423	3.00	19,269.00
Backfill, Granular	C.Y.	339	9.00	3,051.00
Piles, HP 10 x 42	Each	105	800.00	84,000.00
Wall Construction				
Concrete	C.Y.	764	170.00	129,880.00
Reinforcing Steel	Lbs.	114,600	0.40	45,840.00
Cement	Cwt.	5,424	5.00	27,120.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9. Channel				
Flood and Wing Walls				
Concrete Flood Wall, Sta. 202+90 to Sta. 204+97 Lt. Bank				
Wall Construction (Cont'd.)				
Joint Filler	L.F.	40	$ 2.00	$ 80.00
Handrail	L.F.	250	21.00	5,250.00
Wall Toe Drain				
8" Perforated C.M. Pipe	L.F.	250	9.00	2,250.00
Flap Gate for 8" Pipe	Each	2	160.00	320.00
Topsoil	C.Y.	134	6.00	804.00
Sod	S.Y.	1,222	1.30	1,588.60
Landscaping	Job	Sum	-	1,000.00
Sheet Pile Wing Walls at 7th Street NE Bridge, Sta. 157+00				
Wall Construction				
PZ-22 Sheet Pile	S.F.	149	$ 16.00	$ 2,384.00
PZ-27 Sheet Pile	S.F.	3,796	16.00	60,736.00
Concrete Cap				
Excavation, Structure	C.Y.	66	6.00	396.00
Backfill	C.Y.	53	3.00	159.00
Concrete	C.Y.	25	265.00	6,625.00
Reinforcing Steel	Lbs.	2,000	0.40	800.00
Cement	Cwt.	178	5.00	890.00
Topsoil	C.Y.	20	6.00	120.00
Sod	S.Y.	370	1.30	481.00
Sheet Pile Flood Wall, Sta. 172+40 to Sta. 186+25 Lt. Bank				
Site Work				
Excavation, Common	C.Y.	39	$ 3.00	$ 117.00
Excavation, Stripping	C.Y.	269	2.00	538.00
Fill	C.Y.	2,651	2.50	6,627.50
Topsoil	C.Y.	190	6.00	1,140.00
Seeding, Fertilizing & Mulching	Acre	0.4	700.00	280.00
Wall Construction				
PZ-27 Sheet Pile	S.F.	35,302	16.00	564,832.00
Concrete Cap, Anchor, and Deadman				
Excavation, Structure	C.Y.	1,759	6.00	10,554.00
Backfill	C.Y.	1,827	3.00	5,481.00
Backfill Granular	C.Y.	13	9.00	117.00
Concrete	C.Y.	514	215.00	110,510.00
Reinforcing Steel	Lbs.	57,100	0.40	22,840.00
Cement	Cwt.	3,646	5.00	18,230.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9 Channel				
Flood and Wing Walls				
Sheet Pile Flood Wall, Sta. 172+40 to Sta. 186+25 Lt. Bank				
Concrete Cap, Anchor, and Deadman (Cont'd.)				
Anchors & Wale	Lbs.	125,299	$ 2.00	$ 250,598.00
Drilling for Anchors	L.F.	15	3.00	45.00
Handrail	L.F.	1,151	21.00	24,171.00
Dewatering	Job	Sum	-	226,000.00
Contingencies	15 Percent			376,347.40
	Total Flood and Wing Walls			$ 2,860,000.00
Removals				
Stone Walls				
Sta. 125+70 to Sta. 126+60 on RT. Bank	Job	Sum	$ -	$ 700.00
Sta. 126+30 to Sta. 126+80 on Lt. Bank	Job	Sum	-	200.00
Sta. 180+75 to Sta. 182+60 on Lt. Bank	Job	Sum	-	400.00
Sta. 183+10 to Sta. 184+75 on Rt. Bank	Job	Sum	-	500.00
Sta. 185+90 to Sta. 186+75 on RT. Bank	Job	Sum	-	200.00
Sta. 188+05 to Sta. 188+65 on RT. Bank	Job	Sum	-	200.00
Sta. 190+00 to Sta. 191+45 on RT. Bank	Job	Sum	-	250.00
Sta. 193+10 to Sta. 193+45 on RT. Bank	Job	Sum	-	100.00
Wood Walls				
Sta. 174+05 to Sta. 174+35 on Lt. Bank	Job	Sum	-	300.00
Sta. 174+55 to Sta. 176+30 on Lt. Bank	Job	Sum	-	1,300.00
Concrete Walls				
Sta. 126+30 to Sta. 126+80 on Lt. Bank	Job	Sum	-	1,000.00
Sta. 203+50 to Sta. 204+97 on Lt. Bank, including Foundation Piles	Job	Sum	-	8,000.00
Concrete Shoreline Protection Matting				
Sta. 152+50 to Sta. 156+30 on Lt. Bank	Job	Sum	-	3,200.00
Footbridge Abutment at Sta. 193+00 on Rt. Bank	Job	Sum	-	500.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9 Channel				
Removals (Cont'd.)				
12" C.S.P. Inverted Siphon at Sta. 170+80	Job	Sum	$ -	$ 1,500.00
Sheet Piling & Flap Gate at Sta. 159+00 on Lt. Bank	Job	Sum	-	2,000.00
48" R.C.P. and Bulkhead at Sta. 159+90 on Lt. Bank	Job	Sum	-	1,000.00
Power Dam, No. Z-2, at Sta. 169+60	Job	Sum	-	11,000.00
24" x 28" CMP at Sta. 174+00 on Lt. Bank	Job	Sum	-	140.00
Inlet Structure at Sta. 174+15 on Lt. Bank	Job	Sum	-	500.00
Contingencies	15 Percent			4,948.50
	Total Removals			$ 37,938.50
Channel Work				
Clearing and Grubbing	Acre	9.3	2,000.00	18,600.00
Excavation				
Stripping	C.Y.	5,949	2.00	11,898.00
Dredging	C.Y.	50,465	4.00	201,860.00
Common	C.Y.	223,052	3.00	669,156.00
Rock	C.Y.	14,922	10.00	149,220.00
Fill	C.Y.	33,598	2.50	83,995.00
Rock Fill				
Type C	C.Y.	2,847	17.00	48,399.00
Type E	C.Y.	7,030	17.00	119,510.00
Riprap				
Type A	C.Y.	11,624	21.00	244,104.00
Type B	C.Y.	11,790	21.00	247,590.00
Type D	C.Y.	6,230	21.00	130,830.00
Bedding for Riprap	C.Y.	17,938	12.50	224,225.00
Concrete Toe Protection				
Concrete	C.Y.	67	115.00	7,705.00
Reinforcing Steel (Temperature Steel)	Lbs.	9,400	0.40	3,760.00
Cement	Cwt.	476	5.00	2,380.00
Topsoil	C.Y.	2,970	6.00	17,820.00
Seeding, Fertilizing and Mulching	Acre	5.4	700.00	3,780.00
Sodding	S.Y.	1,194	1.30	1,552.20
Guardrail	L.F.	600	16.00	9,600.00
Contingencies	15 Percent			329,397.63
	Total Channel Work			$ 2,525,381.83

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
9 Channel				
Outlet Modifications				
Sta. 125+79 Rt.				
48" thru Flood Wall	Job	Sum	$ -	$ 100.00
Sta. 157+17 Rt.				
12" thru Underpass Wall	Job	Sum	-	120.00
Sta. 158+26 Lt., 18" R.C.P. Outlet				
Remove 18" R.C.P.	L.F.	6	5.00	30.00
Sta. 162+77 Lt., 60" R.C.P. Outlet				
Remove 60" R.C.P.	L.F.	22	10.00	220.00
60" R.C.P., Cl. 2	L.F.	20	150.00	3,000.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
9 Channel				
Outlet Modifications (Cont'd.)				
Sta. 165+82 Lt., 12" R.C.P. Outlet				
12" R.C.P., Cl. 2	L.F.	6	$ 21.00	$ 126.00
Sta. 173+54 Lt., CMP thru Sheet Pile Wall				
Remove 36" R.C.P.	L.F.	60	6.00	360.00
48" R.C.P., Cl. 2	L.F.	64	75.00	4,800.00
48" C.M.P.	L.F.	16	35.00	560.00
60" Dia. Manhole	Each	1	1,500.00	1,500.00
Special Manhole	Each	1	3,000.00	3,000.00
Sta. 174+24 Lt., 2-32" CMP				
Plug	Job	Sum	100.00	100.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL

Construction First Costs

9 Channel

Outlet Modifications (Cont'd.)

Sta. 176+58 Lt. , 24" CMP thru Sheet Pile Wall				
Remove 20" D.I.P.	L.F.	20	$ 5.00	100.00
24" C.M.P.	L.F.	14	20.00	280.00
Catch Basin	Each	1	800.00	800.00
Sta. 176+90 Lt., 72" CMP thru Sheet Pile Wall				
72" C.M.P.	L.F.	34	75.00	2,550.00
96" Dia. Manhole	Each	1	3,300.00	3,000.00
Sta. 180+10 Lt., 30" CMP thru Sheet Pile Wall				
Remove 36" x 24" Arch R.C.P.	L.F.	26	6.00	156.00
30" CMP	L.F.	14	22.00	308.00
Manhole	Each	1	900.00	900.00
Sta. 180+47 Lt., 18" CMP thru Sheet Pile Wall				
Remove 18" R.C.P.	L.F.	30	5.00	150.00
18" CMP	L.F.	15	18.00	270.00
Catch Basin	Each	1	800.00	800.00
Sta. 186+.08 Rt., 21" R.C.P. thru Underpass Ret. Wall				
21" R.C.P., Cl.3	L.F.	62	26.00	1,612.00
Manhole	Each	1	900.00	900.00
Plug Exist. 21" R.C.P.	Each	2	50.00	100.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
9 Channel				
Outlet Modifications (Cont'd.)				
Sta. 186+40 lt., 24" R.C.P. Outlet				
Remove 24" R.C.P. Cl.2	L.F.	74	$ 5.00	$ 370.00
24" R.C.P.	L.F.	32	30.00	960.00
Manhole	Each	1	900.00	900.00
Sta. 190+20 Rt. 12" R.C.P. Outlet				
Remove 12" R.C.P.	L.F.	10	5.00	50.00
12" R.C.P., Cl.3	L.F.	30	21.00	630.00
Manhole	Each	1	900.00	900.00
Sta. 191+70 Rt. 12" P.V.C. Outlet				
Remove 12" P.V.C.	L.F.	15	5.00	75.00
12" R.C.P., Cl.2	L.F.	26	21.00	546.00
Manhole	Each	1	900.00	900.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
9 Channel				
Outlet Modifications				
Sta. 202+49 Rt., 42" R.C.P. Outlet				
Remove 42" R.C.P.	L.F.	24	6.00	144.00
42" R.C.P., Cl 2	L.F.	38	65.00	2,470.00
60" Dia. Manhole	Each	1	1,500.00	1,500.00
Sta. 202+88 Lt.				
Remove 24" R.C.P.	L.F.	21	5.00	105.00
24" R.C.P. thru Flood Wall	Job	Sum		100.00
Sta. 1+40 Rt., 24" R.C.P. Outlet				
Remove 24" R.C.P.,	L.F.	37	5.00	185.00
24" R.C.P., Cl 2	L.F.	34	30.00	1,020.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
9 Channel				
Outlet Modifications				
Sta. 4+05 Lt., 36" R.C.P. Outlet				
Remove 36" R.C.P.	L.F.	20	$ 6.00	$ 120.00
36" R.C.P., Cl. 2	L.F.	20	50.00	1,000.00
Sta. 6+00 RT., 15" R.C.P. Outlet				
Remove 15" CMP	L.F.	40	5.00	200.00
15" R.C.P., Cl. 2	L.F.	60	25.00	1,500.00
Manholes	Each	2	900.00	1,800.00
Plug Pipes	Each	2	50.00	100.00
Contingencies	15 Percent			6,203.00
	Total Outlet Modifications			$ 47,500.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
9 Channel				
Miscellaneous Structures				
Gate Well A at Sta. 160+00 Lt.	Job	Sum	$ -	$ 27,500.00
Log Skimmer at Sta. 168+90 Lt.	Job	Sum	-	500.00
Contingencies	15 Percent			4,200.00
	Total Miscellaneous Structures			$ 32,200.00
Drainage Facility				
Culvert at Sta. 168+50 RT.				
Trench Excatation	C.Y.	235	2.00	470.00
Backfill	C.Y.	250	1.00	250.00
36" R.C.P., 1500D	L.F.	62	50.00	3,100.00
36" R.C.P., Apron	Each	1	500.00	500.00
Contingencies	15 Percent			650.00
		Total Drainage Facility		$ 4,970.00
Silver Lake Dam Modifications				
Concrete Removal				
Apron	C.Y.	34	155.00	5,270.00
Ogee	C.Y.	261	155.00	40,455.00
Right Abutment	C.Y.	24	155.00	3,720.00
Pier No. 3	C.Y.	33	155.00	5,115.00
Access Bridge	C.Y.	19	155.00	2,945.00
Concrete				
Ogee	C.Y.	337	155.00	38,755.00
Right Abutment	C.Y.	133	170.00	22,610.00
Pier No. 3	C.Y.	107	170.00	18,190.00
Access Bridge & Pier Repair	C.Y.	13	170.00	2,210.00
Apron	C.Y.	520	170.00	88,400.00
Reinforcing Steel				
Ogee	Lbs.	28,630	0.50	14,315.00
Right Abutment	Lbs.	11,300	0.50	5,650.00
Pier No. 3	Lbs.	9,030	0.50	4,515.00
Access Bridge	Lbs.	990	0.50	495.00
Tremic Concrete	C.Y.	62	80.00	4,960.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9 Channel				
Silver Lake Dam Modifications (Cont'd.)				
Reinforcing Steel (Cont'd.)				
Apron	Lbs.	44,200	$ 0.50	$ 22,100.00
Cement				
Ogee	Cwt.	2,393	5.00	11,965.00
Right Abutment	Cwt.	944	5.00	4,720.00
Pier No. 3	Cwt.	760	5.00	3,800.00
Access Bridge & Pier Repair	Cwt.	92	5.00	460.00
Tremic Concrete	Cwt.	440	5.00	2,200.00
Apron	Cwt.	3,692	5.00	18,460.00
PZ22 Sheet Piling				
Downstream	S.F.	7,070	13.50	95,445.00
Upstream	S.F.	6,690	13.50	90,315.00
25 Ton Soil Anchors	Each	6	1,860.00	11,160.00
30 Ton Soil Anchors	Each	20	2,170.00	43,400.00
12" Treated Timber Piling Deliv. & Drvn.	L.F.	500	36.00	18,000.00
Handrailing				
Right Abutment	L.F.	41	21.00	861.00
Access Bridge	L.F.	140	29.00	4,060.00
Misc. (Doors, Windows & Skylights)	Job	Sum	-	6,510.00
Metal Roofing	S.F.	370	5.20	1,924.00
Framing Lumber	FBM	775	3.20	2,480.00
Misc. Metals (Stainless Plates, Etc.)	Job	Sum	-	31,000.00
Ladder	Job	Sum	-	1,040.00
Access Bridge	Job	Sum	-	17,920.00
Mechanical Construction				
Hinged Leaf Gate	Job	Sum	-	738,600.00
Tainter Gate Modifications	Job	Sum	-	6,700.00
Cylinders	Job	Sum	-	51,650.00
Trunion Supports	Job	Sum	-	10,330.00
Hydraulic Power Unit w/Controls and Manifold	Job	Sum	-	20,660.00
Hydraulic Piping	Job	Sum	-	36,155.00
Tainter Gate Hoist Removal and New Mounting	Job	Sum	-	10,330.00
Electrical Construction				
Service Switch and Service Connections	Job	Sum	-	3,930.00
Distribution Panels	Job	Sum	-	3,720.00
Step Down Transformer	Job	Sum	-	2,380.00
Lighting	Job	Sum	-	830.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
9 Channel				
Silver Lake Dam Modifications				
Electrical Construction (Cont'd.)				
Conduit				
1"	Job	Sum	$ -	$ 5,060.00
1 1/4"	Job	Sum	-	8,680.00
Trenching and Backfilling	Job	Sum	-	1,240.00
Conductors				
#12	Job	Sum	-	1,450.00
# 8	Job	Sum	-	1,860.00
# 6	Job	Sum	-	1,140.00
Leaf Gate Controls	Job	Sum	-	9,920.00
Leaf Gate Equipment Connections	Job	Sum	-	3,410.00
De-icing System	Job	Sum	-	23,760.00
Tainter Gate Hoist Connections	Job	Sum	-	7,440.00
Miscellaneous	Job	Sum	-	21,200.00
Dewatering	Job	Sum	-	161,630.00
Contingencies	15 Percent			266,500.00
	Total Silver Lake Modifications			$ 2,044,000.00
Restoration of Streets, Roads, Parking Lots, and Sidewalks				
Cemetery Roads				
Remove and Reinstall				
Chainlink Fence	L.F.	415	$ 6.00	$ 2,490.00
Remove Bituminous Pavement	S.Y.	430	2.50	1,075.00
Excavation, Common	C.Y.	72	3.00	216.00
Excavation, Stripping	C.Y.	181	2.00	362.00
Subgrade, Fine Grading	S.Y.	464	0.50	232.00
Bituminous Pavement				
Bituminous Mat'l. for Mixture	Ton	25	208.00	5,200.00
Bituminous Wearing Course	Ton	370	13.20	4,884.00
Bituminous Base Course	Ton	47	13.20	620.00
Bituminous Tack Coat	Gal.	224	1.50	336.00
Crushed Stone Base	Ton	120	6.00	720.00
Topsoil	C.Y.	68	6.00	408.00
Sod	S.Y.	610	1.30	793.00
2nd Avenue NE				
Remove Bituminous Pavement	S.Y.	119	2.50	297.50
Remove Concrete Curb and Gutter	L.F.	65	4.20	273.00
Remove Concrete Sidewalk	S.Y.	36	4.00	144.00
Remove & Replace Barricade	L.F.	62	20.00	1,240.00
Subgrade, Fine Grading	S.Y.	119	0.50	59.50

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9 Channel				
Restoration of Streets, Roads, Parking Lots, and Sidewalks				
2nd Avenue NE (Cont'd.)				
Bituminous Pavement				
Bituminous Mat'l. for Mixture	Ton	3	$ 208.00	$ 624.00
Bituminous Wearing Course	Ton	13	13.20	171.60
Bituminous Base Course	Ton	39	13.20	514.80
Bituminous Tack Coat	Gal.	6	1.50	9.00
Crushed Stone Base	Ton	60	6.00	360.00
Concrete Sidewalk and Curb & Gutter				
Concrete	C.Y.	8	115.00	920.00
Cement	Cwt.	57	5.00	285.00
Granular Base	Ton	6	6.00	36.00
Sod	S.Y.	42	1.30	54.60
2nd Street NE and Parking Lot				
Excavation, Common	C.Y.	39	3.00	117.00
Aggregate Surfacing	Ton	72	8.50	612.00
Remove & Replace Permanent Barricade	L.F.	32	20.00	640.00
Remove & Replace Chainlink Fence	L.F.	210	10.00	2,100.00
1st Street NE & Bit. Parking Lot				
Remove Bituminous Pavement	S.Y.	1,211	2.50	3,027.50
Excavation, Common	C.Y.	170	3.00	510.00
Subgrade, Fine Grading	S.Y.	1,211	0.50	605.50
Bituminous Pavement				
Bituminous Mat'l. for Mixture	Ton	13	208.00	2,704.00
Bituminous Wearing Course	Ton	189	13.20	2,494.80
Bituminous Base Course	Ton	44	13.20	580.80
Bituminous Tack Coat	Gal.	10	1.50	15.00
Crushed Stone Base	Ton	319	6.00	1,914.00
Aggregate Surfacing	Ton	68	8.50	578.00
Remove & Replace Permanent Barricade	L.F.	32	20.00	640.00
Remove & Replace Chainlink Fence	L.F.	310	10.00	3,100.00
Parking Lot and Entrance at Park and Recreation Bldg.				
Remove Bituminous Pavement	S.Y.	1,651	2.50	4,127.50
Excavation, Common	C.Y.	275	3.00	825.00
Subgrade, Fine Grading	S.Y.	1,121	0.50	560.50
Bituminous Pavement				
Bituminous Mat'l. for Mix.	Ton	19	208.00	3,952.00
Bituminous Wearing Course	Ton	123	13.20	1,623.60

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
9 Channel				
Restoration of Streets, Roads, Parking Lots, and Sidewalks				
Parking Lot and Entrance at Park and Recreation Bldg.				
Bituminous Pavement (Cont'd.)				
Bituminous Base Course	Ton	247	$ 13.20	$ 3,260.40
Bituminous Tack Coat	Gal.	56	1.50	84.00
Crushed Stone Base	Ton	341	6.00	2,046.00
East Center Street				
Remove Concrete Pavement	S.Y.	235	7.00	1,645.00
Remove Concrete Sidewalk	S.Y.	13	4.00	52.00
Subgrade, Fine Grading	S.Y.	235	0.50	117.50
Portland Cement Pavement and Curb				
Concrete	C.Y.	60	115.00	6,900.00
Reinforcing Steel	Lbs.	4,800	0.40	1,920.00
Cement	Cwt.	426	5.00	2,130.00
Expansion Joint Material	L.F.	116	2.00	232.00
Concrete Sidewalk				
Concrete	C.Y.	2	115.00	230.00
Cement	Cwt.	14	5.00	70.00
Granular Base	Ton	2	6.00	12.00
Sod	S.Y.	72	1.30	93.60
Parking Lot of County Health Center				
Remove Bituminous Surface	S.Y.	422	2.50	1,055.00
Excavation, Common	C.Y.	70	3.00	210.00
Subgrade, Fine Grading	S.Y.	217	0.50	108.50
Bituminous Pavement				
Bituminous Mat'l. for Mixture	Ton	2	208.00	416.00
Bituminous Wearing Course	Ton	36	13.20	475.20
Crushed Stone Base	Ton	55	6.00	330.00
Mayo Civic Center				
Remove Bituminous Sidewalk	S.Y.	49	2.50	122.50
Remove Concrete Sidewalk	S.Y.	80	4.00	320.00
Bituminous Sidewalk				
Bituminous Mat'l. for Mixture	Ton	0.3	208.00	62.40
Bituminous Wearing Course	Ton	5	13.20	66.00
Crushed Stone Base	Ton	10	6.00	60.00
Concrete Sidewalk				
Concrete	C.Y.	9	115.00	1,035.00
Cement	Cwt.	64	5.00	320.00
Granular Base	Ton	8	6.00	48.00
Contingencies	15 Percent			11,471.06
Total Restoration of Streets, Roads, Parking Lots, and Sidewalks				$ 87,944.76

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
9 Channel (Cont'd.)				
Restoration of Railroad				
Track Work and Loss of Time	Job	Sum	$	$ 18,610.00
Contingencies	15 Percent			2,791.50
		Total Restoration of Railroad		21,401.50
	Total 9 Channel			$ 7,717,686.59
14 Recreation Facilities				
Bike Path (Bituminous)				
Excavation, Common	C.Y.	756	$ 2.00	$ 1,512.00
Excavation, Stripping	C.Y.	52	2.00	104.00
Embankment, Compacted Fill	C.Y.	215	1.50	322.50
Subgrade, Fine Grading	S.Y.	4,735	0.50	2,367.50
Bitmnimous Pavement				
Bituminous Material for Mixture	Ton	28	208.00	5,824.00
Bituminous Wearing Course	Ton	466	13.20	6,151.20
Crushed Stone Base	Ton	958	6.00	5,748.00
Chainlink Fence	L.F.	870	8.00	6,960.00
Topsoil	C.Y.	70	6.00	420.00
Seeding, Fertilizing & Mulching	Acre	0.6	700.00	420.00
Sod	S.Y.	157	1.30	204.10
Landscaping	Job	Sum	-	1,500.00
Signs	Each	12	50.00	600.00
Shelters	Each	2	7,500.00	15,000.00
Contingencies	15 Percent			7,070.00
		Total Bike Path (Bit.)		$ 54,203.30
Bike Path Underpass and Bike Path Approaches on Slopes				
7th Street NE Bridge				
Excavation, Structure	C.Y.	630	$ 6.00	$ 3,780.00
Backfill, Granular	C.Y.	226	9.00	2,034.00
Retaining Wall				
Concrete	C.Y.	213	170.00	36,210.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Cost				
14 Recreation Facilities				
Bike Path Underpass and Bike Path Approaches on Slopes				
7th Street NE Bridge				
Retaining Wall (Cont'd.)				
Reinforcing Steel	Lbs.	31,950	$ 0.40	$ 12,780.00
Cement	Cwt.	1,512	5.00	7,560.00
Concrete Pavement				
Concrete	C.Y.	43	115.00	4,945.00
Reinforcing	Lbs.	2,800	0.40	1,120.00
Cement	Cwt.	277	5.00	1,385.00
Expansion Joint Material	L.F.	212	2.00	424.00
Wall Toe Drain				
8" Perforated C.M. Pipe	L.F.	150	9.00	1,350.00
Flap Gates for 8" Pipe	Each	2	160.00	320.00
Chainlink Fence	L.F.	300	8.00	2,400.00
Electrical Lighting and Power	Job	Sum	-	2,000.00
Signs	Each	6	50.00	300.00
Contingencies	15 Percent			11,491.20
East Center Street Bridge				
Excavation, Structure	C.Y.	222	6.00	1,332.00
Excavation, Rock	C.Y.	139	25.00	3,475.00
Backfill, Granular	C.Y.	248	9.00	2,232.00
Bikeway Wall				
Concrete	C.Y.	246	170.00	41,820.00
Reinforcing Steel	Lbs.	36,900	0.40	14,760.00
Cement	Cwt.	1,747	5.00	8,735.00
Drilling for Rock Anchors	L.F.	230	5.00	1,150.00
Anchor Assemblies	Lbs.	2,990	3.00	8,970.00
Piling, HP 10 x 42	Each	2	560.00	1,120.00
Concrete Pavement				
Concrete	C.Y.	54	115.00	6,210.00
Reinforcing Steel	Lbs.	3,475	0.40	1,390.00
Cement	Cwt.	383	5.00	1,915.00
Expansion Joint Material	L.F.	200	2.00	400.00
Bikeway Bridges				
Concrete	C.Y.	150	170.00	25,500.00
Reinforcing Steel	Lbs.	34,040	0.40	13,616.00
Cement	Cwt.	1,065	5.00	5,325.00
Wall Toe Drain				
8" Perforated C.M. Pipe	L.F.	110	9.00	990.00
Flap Gates for 8" Pipe	Each	2	160.00	320.00
Chainlink Fence	L.F.	595	8.00	4,760.00
Electrical Lighting and Power	Job	Sum	-	2,000.00
Signs	Each	6	50.00	300.00
Contingencies	15 Percent			21,948.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Construction First Costs				
14 Recreation Facilities				
Bike Path Underpass and Bike Path Approaches on Slopes (Cont'd.)				
3rd Avenue SE Bridge				
Excavation, Structure	C.Y.	315	$ 6.00	$ 1,890.00
Backfill, Granular	C.Y.	113	9.00	1,017.00
Retaining Wall				
Concrete	C.Y.	107	170.00	18,190.00
Reinforcing	Lbs.	16,000	0.40	6,400.00
Cement	Cwt.	756	5.00	3,780.00
Concrete Pavement				
Concrete	C.Y.	22	115.00	2,530.00
Reinforcing Steel	Lbs.	1,400	0.40	560.00
Cement	Cwt.	156	5.00	780.00
Expansion Joint Material	L.F.	140	2.00	280.00
Wall Toe Drain				
8" Perforated C.M. Pipe	L.F.	75	9.00	675.00
Flap Gate for 8" Pipe	Each	1	160.00	160.00
Chainlink Fence	L.F.	150	8.00	1,200.00
Electical Lighting and Power	Job	Sum	1,000.00	1,000.00
Signs	Each	3	50.00	150.00
Contingencies	15 Percent			5,791.80

Total Bike Path Underpass and Bike Path Approaches and Slopes $ 300,771.00

Total 14 Recreation Facilities....................$ 177,487.15
(50% of $354,974.30)

30 Engineering and Design 12% of Direct Costs.............$ 1,126,275.86

31 Supervision and Administration

Supervision and Inspection 4.5% of Direct Costs............$ 422,400.00
Overhead 348,700.00

TOTAL CONSTRUCTION FIRST COSTS....................$11,283,000.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Non-Federal First Costs				
1 Lands				
Private Lands				
Cemetery				
Temporary Right-of-Way	Acre	1.3	$ 4,500.00	$ 5,850.00
Commercial				
Permanent Right-of-Way	Acre	0.7	9,000.00	6,300.00
Temporary Right-of-Way	Acre	0.1	4,500.00	450.00
Railroad				
Bike Path Easement	Job	Sum	-	500.00
Deadman Anchor Easement	Job	Sum	-	1,500.00
Sanitary Sewer Easement	Job	Sum	-	5,750.00
Agreement for Easement	Each	3	150.00	450.00
City Owned Lands				
Channel Improvement				
Easement	Acre	26.0	8,900.00	231,400.00
Recreation Permanent				
Right-of-Way	Acre	2.0	25,000.00	50,000.00
Construction Temporary				
Easement	Acre	3.0	4,500.00	13,500.00
Administration/Acquisition Costs				35,100.00
Contingencies	15 Percent			52,200.00
Total 1 Lands....................................				$ 403,000.00
2.3 Utility Relocations				
15" Sanitary Sewer, Sta. 157+12 to Sta. 185+40 RT. Bank				
Abandon Manholes				
Sta. 172+10 Rt. 8.6' Deep	Each	1	$ 150.00	$ 150.00
Sta. 174+60 Rt. 8.2' Deep	Each	1	150.00	150.00
Remove Manholes				
Sta. 171+40 Rt. 6.6' Deep	Each	1	250.00	250.00
Sta. 177+65 Rt. 16.1' Deep	Each	1	500.00	500.00
Sta. 181.00 Rt. 17.7' Deep	Each	1	500.00	500.00
Sta. 183.75 Rt. 16.1' Deep	Each	1	500.00	500.00
Remove 12" V.C. Pipe				
Sta. 176+00 Rt.to Sta. 179+70 Rt.	L.F.	370	10.00	3,700.00
Sta. 180+40 Rt.to Sta. 184+80 Rt.	L.F.	440	10.00	4,400.00
Plug Pipes	Each	12	50.00	600.00
Trench Excavation and Backfill				
0' to 6' Deep	L.F.	332	7.50	2,490.00
6' to 10' Deep	L.F.	1,409	11.00	15,499.00
10' to 13' Deep	L.F.	72	16.00	1,152.00
13' to 15' Deep	L.F.	57	22.00	1,254.00
15' to 17' Deep	L.F.	281	32.00	8,992.00
17' to 19' Deep	L.F.	168	38.00	6,384.00
19' to 21' Deep	L.F.	315	73.00	22,995.00
Trench Excavation, Rock	C.Y.	434	21.00	9,114.00
Backfill, Granular	C.Y.	255	6.50	1,657.50
15" Sanitary Sewer Pipe	L.F.	2,580	20.00	51,600.00
16" D.I. Pipe w/Mechanical Joint	L.F.	112	28.00	3,136.00
30" Steel Casing by Bore & Jack	L.F.	62	120.00	7,440.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Non-Federal First Costs				
2.3 Utility Relocations (Cont'd.)				
Twin Siphons				
Trench Excavation	C.Y.	640	$ 5.00	$ 3,200.00
Backfill	C.Y.	462	3.00	1,386.00
Backfill, Granular	C.Y.	370	6.50	2,405.00
10" D.I. Pipe w/Mechanical Joint	L.F.	76	20.00	1,520.00
10" D.I. Pipe w/Ball Joint, River Crossing	L.F.	224	120.00	26,880.00
Standard Sanitary Sewer Manholes				
Sta. 164+05 Rt. 7.5' Deep	Each	1	900.00	900.00
Sta. 166+03 Rt. 7.5' Deep	Each	1	900.00	900.00
Sta. 170+30 Rt. 5.0' Deep	Each	1	850.00	850.00
Sta. 171+58 Rt. 4.8' Deep	Each	1	850.00	850.00
Sta. 172+70 Rt. 6.7' Deep	Each	1	900.00	900.00
Sta. 174+58 Rt. 7.3' Deep	Each	1	900.00	900.00
Sta. 174+95 Rt. 10.5' Deep	Each	1	1,000.00	1,000.00
Sta. 176+00 Rt. 14.2' Deep	Each	1	1,500.00	1,500.00
Sta. 180+38 Rt. 12.1' Deep	Each	1	1,400.00	1,400.00
Sta. 182+55 Rt. 20.3' Deep	Each	1	5,000.00	5,000.00
60" Dia. Sanitary Sewer Manhole, Sta. 157+12 Rt. 10.7' Deep	Each	1	1,500.00	1,500.00
Siphon Manholes				
Sta. 158+68 Rt. 6.0' Deep	Each	1	4,000.00	4,000.00
Sta. 160+48 Rt. 7.5' Deep	Each	1	4,000.00	4,000.00
2" Insulation	S.F.	1,920	1.50	2,880.00
Restore Sanitary Sewer Service	Each	2	300.00	600.00
Overhead Power at Sta. 170+20 & Sta. 161+00 to Sta. 169+70 Rt.	Job	Sum	-	18,000.00
10" Gas Line at Sta. 170+70 & Sta. 171+35 to Sta. 172+00 Rt.	Job	Sum	-	60,000.00
Overhead Power Sta. 181+30 to Sta. 184+90 Rt.	Job	Sum	-	6,000.00
4" Water Service at Sta. 184+00 - Rt.	Job	Sum	-	8,000.00
Hydrant Extension at Sta. 158+45 - 195' Lt.	Job	Sum	-	300.00

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Non-Federal First Costs				
2.3 Utility Relocations (Cont'd.)				
Raise Manholes				
at Sta. 158+75 - 270' Lt.	Job	Sum	$ -	$ 200.00
at Sta. 158+85 - 220' Lt.	Job	Sum	-	200.00
Contingencies	15 Percent			44,660.18
Total 2.3 Utility Relocations..................$				342,394.68
9 Channel				
Removal				
Building at Sta. 177+50 Lt. Bank	Job	Sum	-	$ 2,000.00
Contingencies		15 Percent		300.00
Total 9 Channel................................$				2,300.00
14 Recreation Facilities (50% of $354,974.30).................$				177,487.15
TOTAL NON-FEDERAL FIRST COSTS....................$				925,181.83
TOTAL ESTIMATED PROJECT COST.....................$				12,208,181.83

DESIGN MEMORANDUM NO. 2 FEATURE
FLOOD CONTROL SOUTH FORK ZUMBRO RIVER
ROCHESTER, MINNESOTA
STAGE 1B
DELIVERY ORDER NO. 3

APPENDIX E
CONSTRUCTIBILITY

Prepared by
Wallace Holland Kastler Schmitz & Company
Consulting Engineers and Planners
Mason City and Dubuque, Iowa and Rochester, Minnesota

APPENDIX E
CONSTRUCTIBILITY

TABLE OF CONTENTS

EXHIBITS

1. INTRODUCTION

Stage 1B channel modifications on the South Fork of the Zumbro River will extend from the North Broadway Street bridge 8,007 feet upstream to the 3rd Avenue SE bridge. This stage includes 500 feet of Bear Creek downstream of the 4th Street SE bridge. Work includes the following:

1) Modifications to the Silver Lake Dam
2) Scour Protection at the North Broadway Bridge
3) Scour Protection at the 7th Street NE Bridge
4) Scour Protection at the Dakota, Minnesota & Eastern Railroad Bridge (former Chicago & North Western Railroad)
5) Scour Protection at the Center Street Bridge
6) Channel Excavation from 1 foot to 5 feet in Depth
7) Slope Protection with Riprap and Rockfill that varies from 1 Vertical on 3 Horizontal to 1 Vertical on 2 Horizontal
8) Approximately 400 feet of Wing Walls
9) 905 feet of Concrete Flood Walls
10) 1,195 feet of Sheet Pile Walls

A bicycle path will be constructed on the right bank of the Zumbro River for the entire stage. The bicycle path is approximately one mile long and includes bridge underpasses at 7th Street NE, Center Street, and 3rd Avenue SE.

Approximately 2,800 feet of 15-inch sanitary sewer along the right bank from 7th Street NE to East Center Street will be constructed, including 150 feet of twin 10-inch inverted siphons across Silver Creek.

This sewer will replace the existing 12-inch sanitary sewer siphon at

Sta. 170+80 and 12-inch sanitary sewer on the right bank from Station 171+40 to Station 185+40.

2. CONSTRUCTION SEQUENCE

Stage 1B construction will be done in two phases. The first phase will be the modifications to Silver Lake dam and adjacent concrete floodwalls and wingwalls. This work will start in September and will use cofferdams to maintain the water level through the fall and winter months. The second phase will begin in April after the Spring runoff has occurred. To eliminate as much water as possible in the river channel, the Silver Lake dam tainter gates must be raised. All work near or in the channel bottom shall be performed during the spring and summer and must be completed by mid-October.

Careful consideration has been given to the following construction activities. Included with this list of activities is a construction schedule bar chart. See Exhibit D - Construction Schedule Bar Chart.

LIST OF ACTIVITIES FOR CONSTRUCTION SCHEDULE BAR CHART

1. Mobilization
2. Construct cofferdam upstream and downstream of the Silver Lake Dam for tainter gate modification (left side of dam).
3. Modify tainter gate side of dam and construct new access bridge.
4. Construct concrete apron on left side of Silver Lake dam.
5. Remove existing concrete and stone wall and construct left bank floodwall and concrete side slope at Sta. 126+50.
6. Construct right bank flood wall and concrete slope, at Sta. 126+50.
7. Remove cofferdam upstream and downstream.

8. Raise tainter gates and lower water elevation to approximately 965.

9. Construct cofferdam upstream and downstream of the Silver Lake Dam for ogee modification (right side).

10. Modify ogee side of dam.

11. Construct concrete apron on right side of dam.

12. Remove cofferdam upstream and downstream.

13. Start Silver Lake channel dredging to 7th St. bridge (approximately Sta. 158+80).

14. Clearing and grubbing along banks to end of project.

15. Construct concrete scour protection and place gabions to left abutment and pier of Broadway Street bridge.

16. Excavate temporary channel along left edge of proposed channel from Sta. 155+00 to Sta. 205+00 and Sta. 6+50 of Bear Creek for dewatering purposes and remove a part (left side) of Dam No. Z-2.

17. Construct concrete scour protection to abutment and pier and place gabions on right side of North Broadway bridge.

18. Simultaneously construct scour protection to the left abutments on all bridges during the temporary channel excavation.

19. Remove and replace 48-inch C.I.P. storm sewer in right bank at Sta. 125+88 and remove rubble wall from Sta. 125+85 to Sta. 126+50.

20. Remove 8-inch and 10-inch siphons and install new twin 10-inch siphons at approximately Sta. 156+33.

21. Excavate channel from approximately Sta. 156+00 to South side of 7th Street bridge.

22. Shape banks to proper slopes (South side of 7th Street bridge) from Sta. 151+90 to Sta. 158+80 both right and left banks.

23. Begin outlet modification of storm sewers.

24. Construct wing wall extensions at 7th Street bridge.

25. Construct bicycle path underpass under the east end of 7th Street bridge.

26. Construct concrete scour protection and place 12-inch bedding and 21-inch riprap under 7th Street bridge.

27. Begin placement of bedding, riprap and rockfill.

28. Construct bicycle path on slopes of both sides of 7th Street Bridge

(north and south).

29. Remove 48-inch R.C.P. and bulkhead at diffuser box and construct Gate Well A (for power plant).

30. Construct concrete retaining wall on right bank from Sta. 169+40 to Sta. 174+79.

31. Construct 15-inch sanitary sewer from 7th Street bridge to Center Street bridge and remove and/or abandon sanitary sewer and sanitary sewer manholes.

32. Excavate channel to Dakota, Minnesota and Eastern Railroad bridge and remove the rest of Dam No. Z-2.

33. Remove 12-inch C.S.P. sanitary sewer siphon at approximately Sta. 170+80.

34. Construct log skimmer in front of power plant intake structure (anytime).

35. Construct sheet pile on left bank from Sta. 172+37 to Sta 174+40.

36. Shape left and right bank from Sta. 158+80 to Sta. 176+00.

37. Construct concrete scour protection and place bedding and gabions under Dakota, Minnesota & Eastern Railroad bridge.

38. Remove building at 2nd Street NE.

39. Remove stone wall on left bank from Sta. 180+75 to Sta. 182+60.

40. Remove stone walls on right bank at north and south sides of Center Street and construct concrete wing wall extensions on right bank at north and south sides of Center Street bridge.

41. Excavate channel from Dakota, Minnesota and Eastern Railroad bridge to south side of Center Street bridge.

42. Shape right bank slope from Sta. 176.00 to Sta. 186+50.

43. Construct sheet pile wall on left bank fro Sta. 174+40 to Sta. 182+60.

44. Construct bicycle path underpass under the east end of Center Street bridge, and construct bicycle path underpass approaches on the bank slopes.

45. Construct concrete slope protection from Sta. 182+60 to Center Street bridge left abutment.

46. Construct concrete scour protection and place bedding and gabions under Center Street bridge.

47. Excavate channel from the south side of Center Street bridge to 4th

Street SE bridge and 3rd Avenue SE bridge.

48. Remove stone walls at approximately -
    Sta. 186+15 to 186+75 on right bank
    Sta. 188+10 to 188+65 on right bank
    Sta. 190+00 to 191+40 on right bank
    Sta. 192+90 to 193+45 on right bank

49. Remove foot bridge abutment on right bank at approx. Sta. 193+05.

50. Remove existing concrete wall from Sta. 203+50 to 204+95.

51. Shape bank slopes from South side of Center Street bridge to 4th Street SE and 3rd Avenue SE bridge (right sides).

52. Construct bike underpass at 3rd Avenue SE bridge and construct underpass approach on left bank slope.

53. Place bedding and riprap at 3rd Avenue SE bridge.

54. Place bedding and gabions at 4th Street SE bridge.

55. Construct concrete wall from Sta. 202+90 to Sta. 204+95, left bank.

56. Construct bicycle path on the right bank.

57. Construct plate beam guardrail on right bank around Sta. 190+00.

58. Place topsoil, seed and mulch.

59. Reconstruct all disturbed portions of pavement on Center Street and entrance to Mayo Civic Center (possibly) with PC concrete.

60. Reconstruct parking lots disturbed by sanitary sewer location.

61. Redredge Silver Lake at conclusion of project if a siltation problem results from upstream channel excavation.

3. MAJOR CONSTRUCTION ACTIVITIES

Silver Lake Dam: The tainter gate side of the dam should be completed first, then the ogee portion. This allows opening the new tainter gates and lowering the upstream water to its lowest elevation for channel excavation, and upstream construction in phase 2.

Clearing and Grubbing: The Contractor shall dispose of the cleared and grubbed trees and debris from along the construction limits by means

acceptable to the City and the Corps of Engineers. Existing utilities within the construction limits will be located and marked.

After clearing and grubbing, all areas will be stripped to receive fill, riprap, and rockfill. Material suitable for topsoil should be temporarily stockpiled at predetermined locations.

Channel Excavation: The channel excavation through Silver Lake to the 7th Street bridge can be dredged prior to the opening of the new tainter gates. After the opening of the new tainter gates and lowering of the water elevation, a temporary low flow channel 20 feet wide can be constructed along the left portion of the channel from 7th Street bridge to 3rd Avenue SE bridge. This temporary channel is to contain the flow and dewater the right portion of the channel for excavation. Deepening of the channel bed varies from 1 foot to 5 feet below its present elevation. These operations shall take place during the spring and summer season and must be completed before mid-October.

During channel, slope, and retaining wall excavations, bedrock will be encountered. (Bedrock locations are shown on the plans.) The estimated rippable depth is 0'-7'. Bedrock which cannot be ripped shall be removed by blasting, jackhammering, or other approved means. If blasting is required, the contractor's blasting procedure shall conform to state laws and municipal ordinances.

Bank Improvement: During channel excavation, the Contractor shall shape banks to proper slope and elevation, then bank slopes can be protected with bedding, riprap, rockfill, and gabions. All materials used shall meet Corps of Engineers' specifications.

Riprap shall be placed on slopes ranging from 1 Vertical on 3 Horizontal to 1 Vertical on 2 1/2 Horizontal. Rockfill 6 feet deep shall be placed at 1 Vertical on 2 Horizontal slopes at specified locations.

Concurrently and/or prior to the bank improvements, removal of existing walls, and/or modifications, and construction of the new wing walls and flood walls should take place.

The flood walls are located as follows:

1) Left and right bank flood walls located directly downstream of the Silver Lake Dam from the dam abutments to the Broadway Street bridge abutments.

2) Concrete flood wall running on the right bank from Sta. 169+40 to Sta. 174+79 (the north side of Dakota, Minnesota & Eastern Railroad bridge abutment).

3) Sheet pile flood wall that runs along the left bank from Sta. 172+40 (the north side abutment of the Dakota, Minnesota & Eastern Railroad bridge) to Sta. 182+63. Due to limited space along the existing building at Sta. 181+00 and the Art Center building, a sheet pile wall deadman may be used rather than a concrete deadman.

4) Sheet pile flood wall that runs on the left bank from the south abutment of Center Street bridge to Sta. 186+25.

5) Remove portions of existing wall and construct new concrete flood wall that runs on the left bank from Sta. 202+90 to Sta. 205+00.

6) Existing sheet pile wall, Sta. 169+20 to Sta. 172+50, left bank. During construction, up to 11 feet of earth will be removed from in front of the wall prior to placement of rockfill. The sheet piling should be checked for bending and lateral resistance of toe with this earth removed, and the need for temporary bracing should be assessed.

7) Existing concrete wall, Sta. 182+50 to Center Street bridge, left bank. This wall should be considered for scour protection similar to the adjacent bridge abutment. The structural adequacy of the retaining wall should be checked for conformance to current loading specifications for flood walls.

Wing wall extensions are required at the following locations:

1) 7th St. NE bridge has four existing concrete wing walls which require extensions with sheet pile walls approximately 130 feet in total length.

2) Center Street bridge has two concrete wing walls to be extended on the right bank for a total length of approximately 290 feet.

Storm Sewer Outlets: The construction of storm sewer outlets will be completed simultaneously with bank improvements. The outlet pipe may have to be shortened or lengthened depending upon the cutting or filling required on the bank.

Scour Protection to Bridges: While the river is at its low water condition, the scour protection can be completed on four bridges:

1) North Broadway Bridge
2) 7th Street NE Bridge
3) Dakota, Minnesota & Eastern Railroad Bridge
4) Center Street Bridge

The scour protection to these bridges consists of concrete additions to the abutments and piers. Prior to diversion of the water through the temporary channel, the scour protection must be completed on the left abutments. The channel bottom will receive granular bedding and gabions, or riprap, as specified on the plans.

When constructing scour protection and sheetpile wall (at the west abutment) underneath the Dakota, Minnesota & Eastern Railroad bridge, it will be necessary to schedule construction closely with the Dakota, Minnesota & Eastern Railroad Company train schedules. As of December, 1986, there is no definite train schedule and daily train traffic is one or two trains each way per day.

Construction of 15-inch Sanitary Sewer on the Right Side:
Construction of the 15-inch sanitary sewer must be coordinated with the construction of the floodwall, wingwall, and bank protection.

Foreseeable problems with the construction of the sewer line are:

1) Boring under the railroad tracks. Proposed sewer flow line is within approximately one foot of the top of bedrock. A horizontal rock boring may be required to install a 30-inch steel casing if rock is encountered during the boring and jacking operations.

2) The floodwall from Sta. 169+40 to Sta. 174+79 must be constructed before the sewer line can be installed due to the depth of the floodwall.

3) Due to the depth (approximately 20 feet deep) of the 15-inch sanitary sewer, the construction of the wingwall from Sta. 182+70 to 184+75 must be completed first.

4) The Park and Recreation Department will have some temporary inconvenience during the construction of the sanitary sewer across Center Street and through Park and Recreation's parking lot. Center Street may be temporarily closed during the sanitary sewer construction.

In summary, the construction of the 15-inch sanitary sewer will have to be closely scheduled and coordinated with construction of floodwalls and wing walls.

Bicycle Path: The bicycle path will be constructed in the following three phases:

Phase One - Construction of three underpasses;

Phase Two - Construction of bank slope approaches to underpasses;

Phase Three - Construction of bicycle path including excavation, embankment, subgrading, placing of aggregate base material, and asphalt material.

Phase Three must take place during the paving season which is approximately May 15 to November 1. Reconstruction of parking lots disturbed by sanitary sewer and bank slope construction must also be completed during the paving season.

Cleanup Final stages of construction will include disposal of excess

materials, placing top soil, sodding, seeding and mulching, and general cleanup of the project area.

3rd Avenue SE Bridge: The City of Rochester is currently in the process of designing a new bridge to replace the existing 3rd Avenue SE bridge. The construction of a new bridge at this location will alter the final design of the channel and will change quantities.

4. POWER PLANT

In a typical year, the Silver Lake power plant uses river water for cooling purposes from September 1 to June 1 when river water temperature is below 70°F. Well water is used as a cooling source from June 1 to September 1 when water temperature is above 70°F.

5. HAUL ROADS

Temporary access roads must be constructed for hauling purposes. The access roads to the channel bottom will be used for removing excavated material from the channel and slopes, and may be used to haul in bedding, riprap and rockfill material. There are several streets adjacent to the project site that may be used for hauling purposes, but the Contractor will need an agreement with the City to repair construction related street damage when the project is completed. A temporary access bridge and road could be constructed by the use of floating barges across Silver Creek.

Certain roads in the cemetery may be used as haul roads with the Owner's permission. It will be the Contractor's responsibility to restore the roads which may be damaged by construction operations.

The disposal sites for excess excavated materials are indicated on ______________ and possible haul routes are shown on Exhibit A.

6. DISPOSAL AREAS

Disposal of an estimated 274,000 cubic yards of excavated material is required. A large tract of land located just _______________ side of Rochester is the only area necessary to accommodate the excess. Calculations show that _________ area is capable of storing the total channel excavation material quantity.

Approximately 50,000 cubic yards of select excavated material is required to fill an area just north of the cemetery.

7. COFFERDAMS AND DEWATERING

The use of cofferdams will be necessary in several project construction phases; for example, the dam modification, bridge scour protection, and concrete flood walls. The cofferdams should be low enough to permit overtopping or breaching to minimize the effect of upstream flooding.

8. CONSTRUCTION MATERIAL AVAILABILITY

Construction materials required for the project consist of 32,700 C.Y. of riprap, 21,800 C.Y. of granular bedding, 5,000 C.Y. of fill for gabion baskets, and 9,900 C.Y. of rockfill. All the materials mentioned above, including the coarse aggregate for concrete, can be obtained from the following two quarries in the Rochester area. These two quarries lie in the Shakopee and Oneota formations.

1) Goldberg Quarry located five miles north on Highway 63 from Broadway

Street bridge and one mile west on C.S.A.H. 14.

2) Hammond Quarry located 12.8 miles north on Highway 63 from Broadway Street bridge and two miles east on C.S.A.H. 11 on the north side of the road.

Further testing of the quarries is needed to determine acceptability by the Corps of Engineers. Both quarries have been tested by the Minnesota Department of Transportation and have passed their specifications.

It was brought to our attention by Twin City Testing Engineering and Laboratories that the Goldberg pit may be running out of the high quality material.

Refer to Exhibits B & C which show quarry locations.

#62 DM2FCSFZ.DT

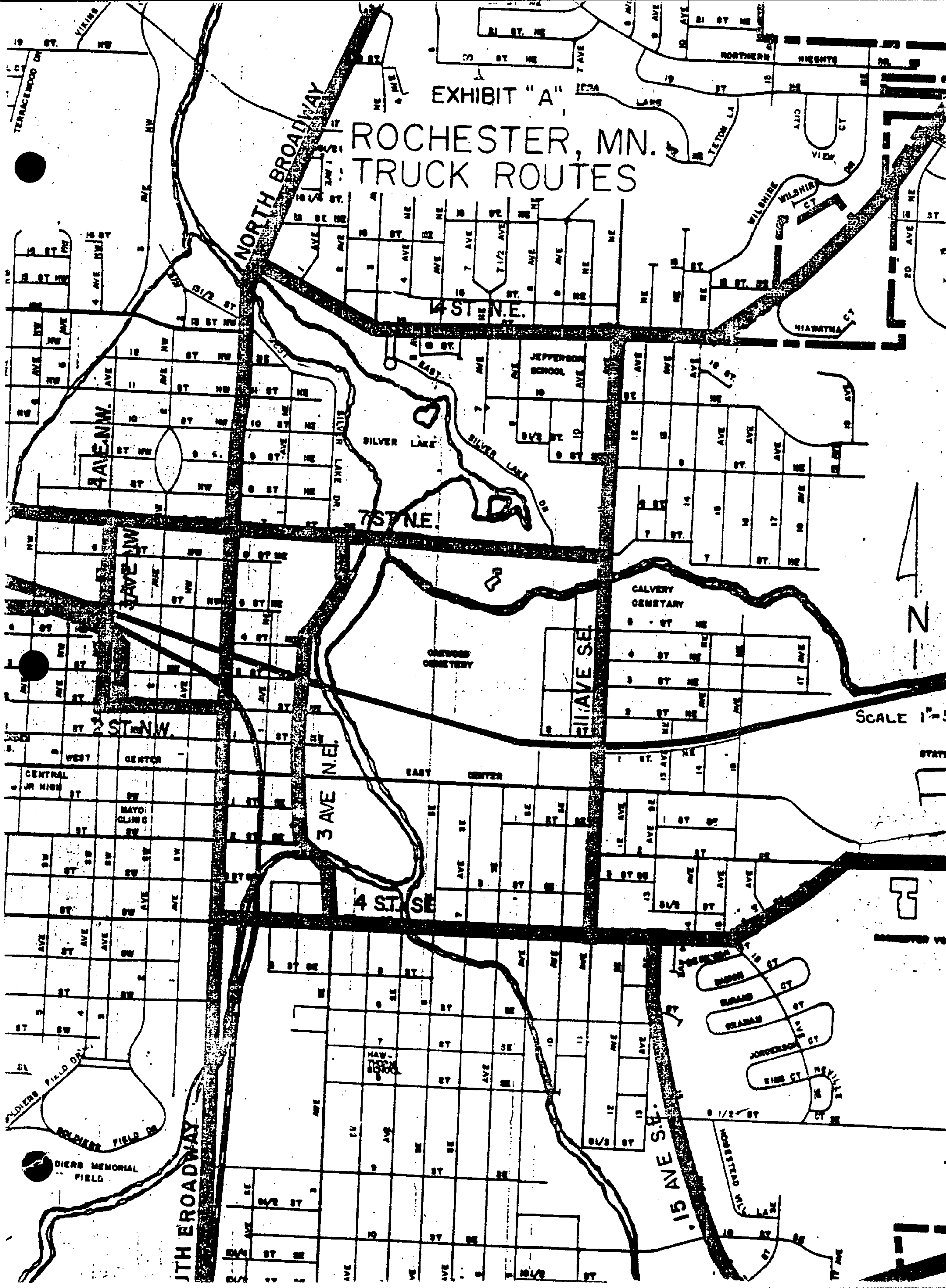


EXHIBIT "A"
ROCHESTER, MN.
TRUCK ROUTES
NORTH BROADWAY
14 ST. N.E.
7 ST N.E.
4 AVE N.W.
2 ST N.W.
3 AVE N.E.
4 ST. SE
11 AVE S.E.
15 AVE S.E.
SILVER LAKE
SILVER LAKE DR.
JEFFERSON SCHOOL
CALVERY CEMETARY
OAKWOOD CEMETERY
WEST CENTER
EAST CENTER
CENTRAL JR HIGH
MAYO CLINIC
HAWTHORN SCHOOL
SOLDIERS FIELD DR.
NORTHERN HEIGHTS
WILSHIRE
HIAWATHA CT
SCALE 1"=
N

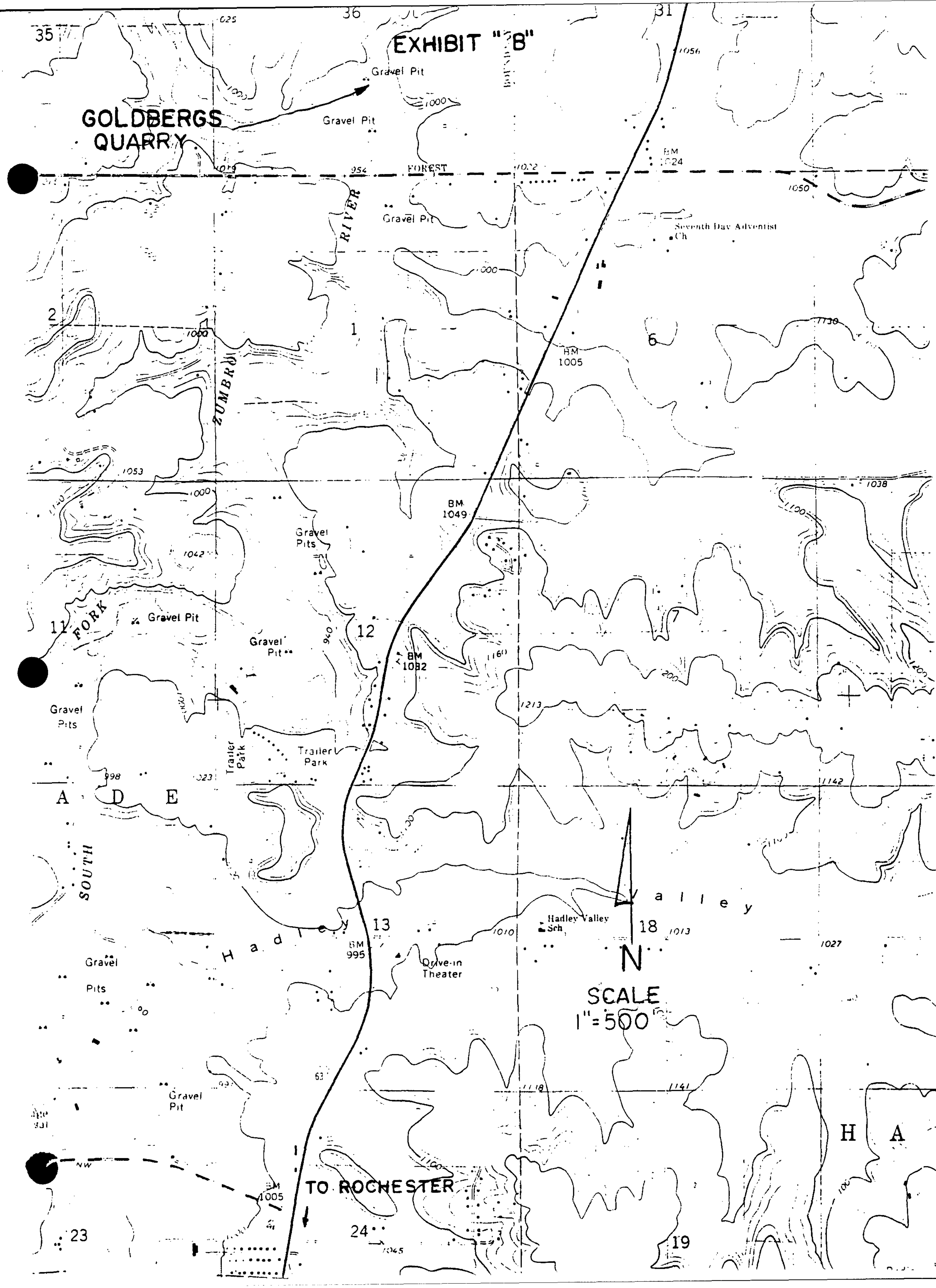
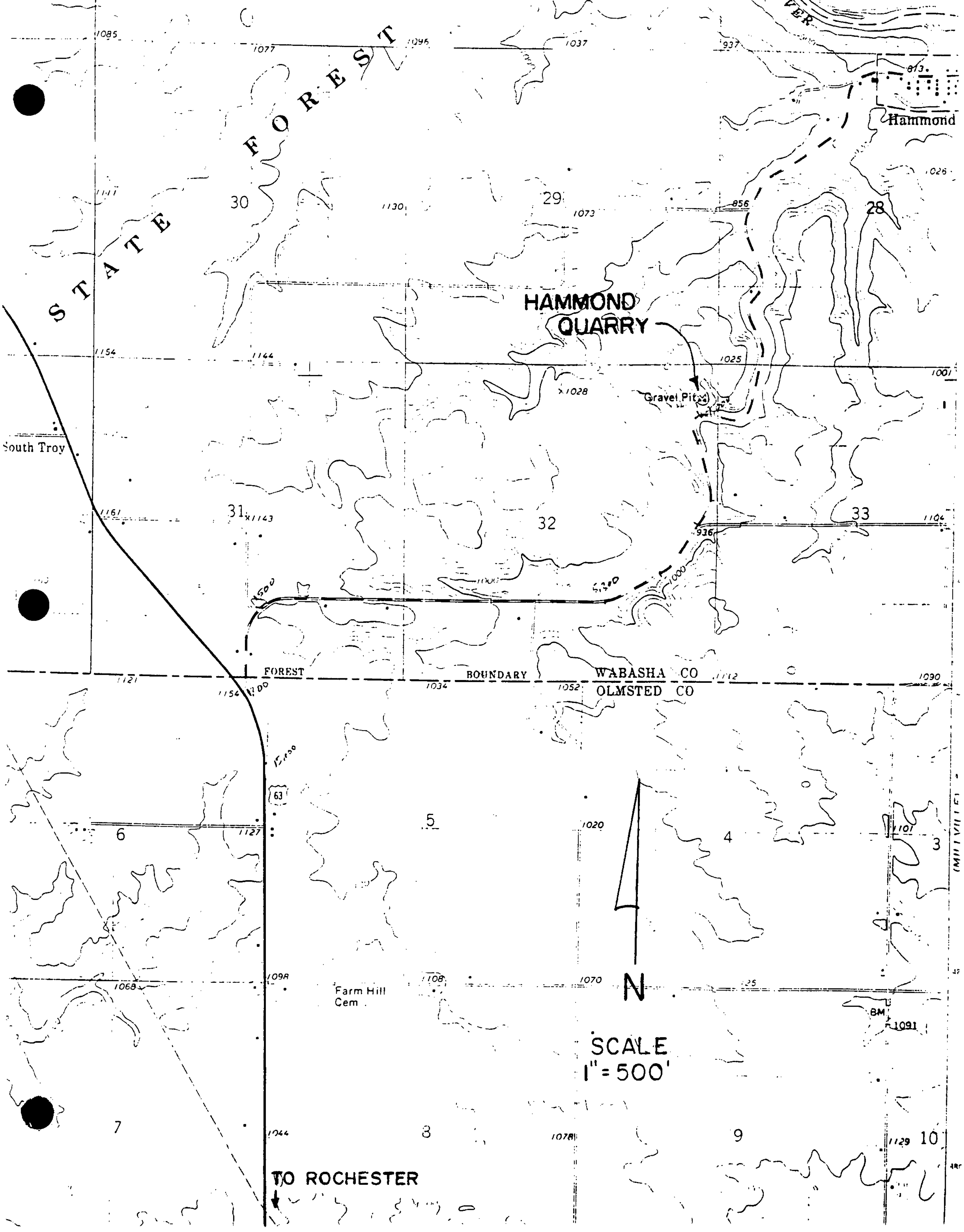


EXHIBIT "B"
GOLDBERGS QUARRY
Gravel Pit
Gravel Pit
FOREST
Gravel Pit
RIVER
Seventh Day Adventist Ch
ZUMBRO
BM 1005
BM 1049
Gravel Pits
FORK
Gravel Pit
Gravel Pit
BM 1032
Gravel Pits
Trailer Park
Trailer Park
A D E
SOUTH
Valley
Hadley
Hadley Valley Sch
BM 995
Drive-in Theater
N
SCALE 1"=500'
Gravel Pits
Gravel Pit
TO ROCHESTER
BM 1005
H A

EXHIBIT "C"


BRO
STATE FOREST
RIVER
Gravel Pit
Hammond
HAMMOND QUARRY
Gravel Pit
South Troy
FOREST BOUNDARY
WABASHA CO
OLMSTED CO
63
Farm Hill Cem
BM
1091
N
SCALE 1" = 500'
TO ROCHESTER
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1129

CONSTRU

ROCHESTER STAGE IB, FEAT

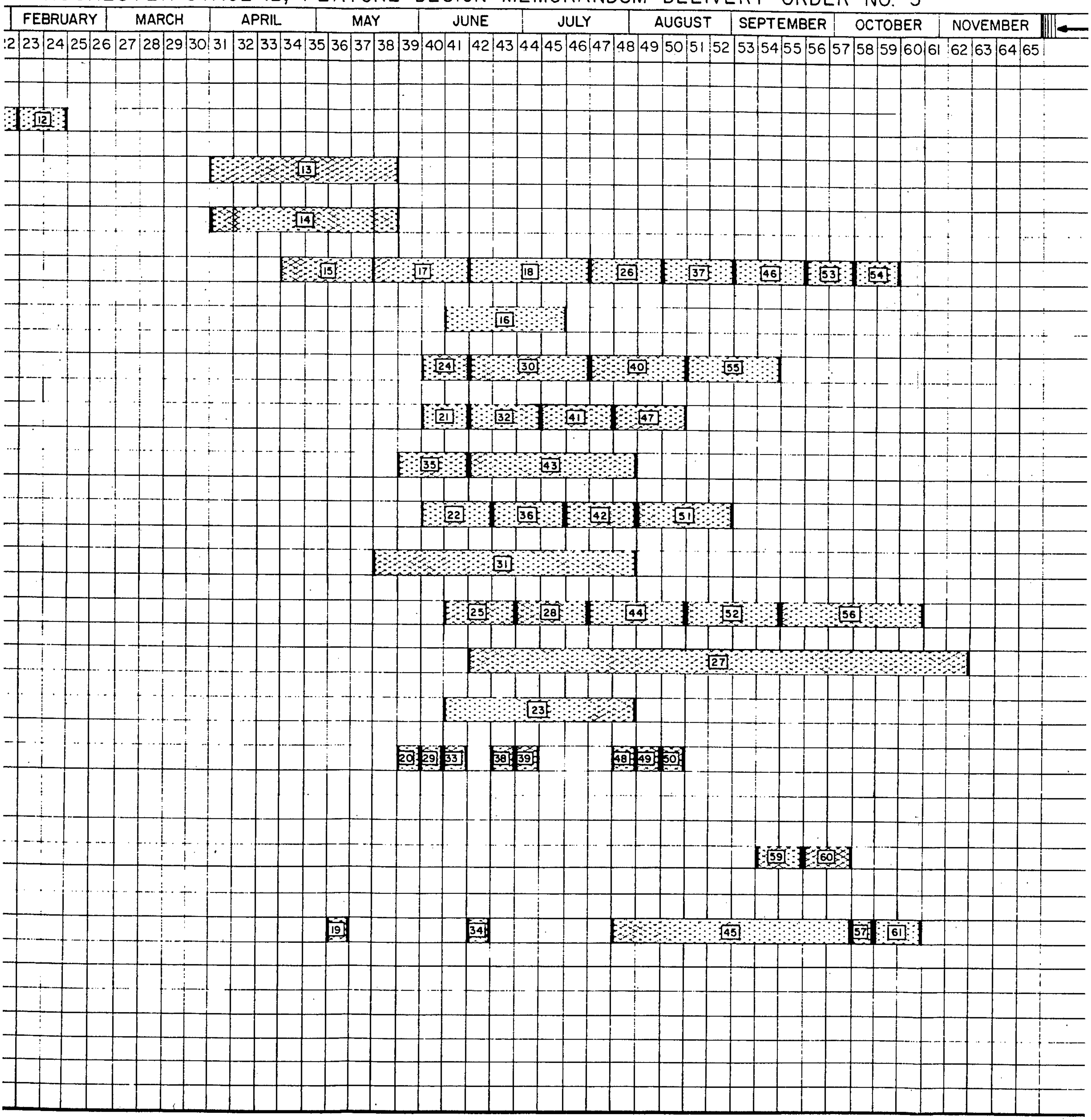
MONTH: SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | M

WEEK: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 3

DESCRIPTION	
ATION	1
VER LAKE DAM MODIFICATION	2, 3, 4, 7, 8, 9, 10, 11, 12
EDGE SILVER LAKE	13
EAR AND GRUB BANKS	14
DGE SCOUR PROTECTION	15
CAVATE TEMPORARY CHANNEL	
NST. CONC. FLOODWALLS & WINGWALLS	5, 6
CAVATE MAIN CHANNEL	
NSTRUCT SHEET PILE WALLS	
AFE BANK SLOPE	
RY SEWER RELOCATION	
NSTRUCT BIKE PATH	
DDING, RIPRAP AND ROCKFILL	
DIFY STORM SEWERS	
MOVE MISCELLANEOUS ITEMS	
PSOIL, SEED AND MULCH	
STORATION OF STREETS, ROADS, PARKING LOTS AND SIDEWALKS	
CELLANEOUS	19

CONSTRUCTION SCHEDULE

ROCHESTER STAGE IB, FEATURE DESIGN MEMORANDUM DELIVERY ORDER NO. 3



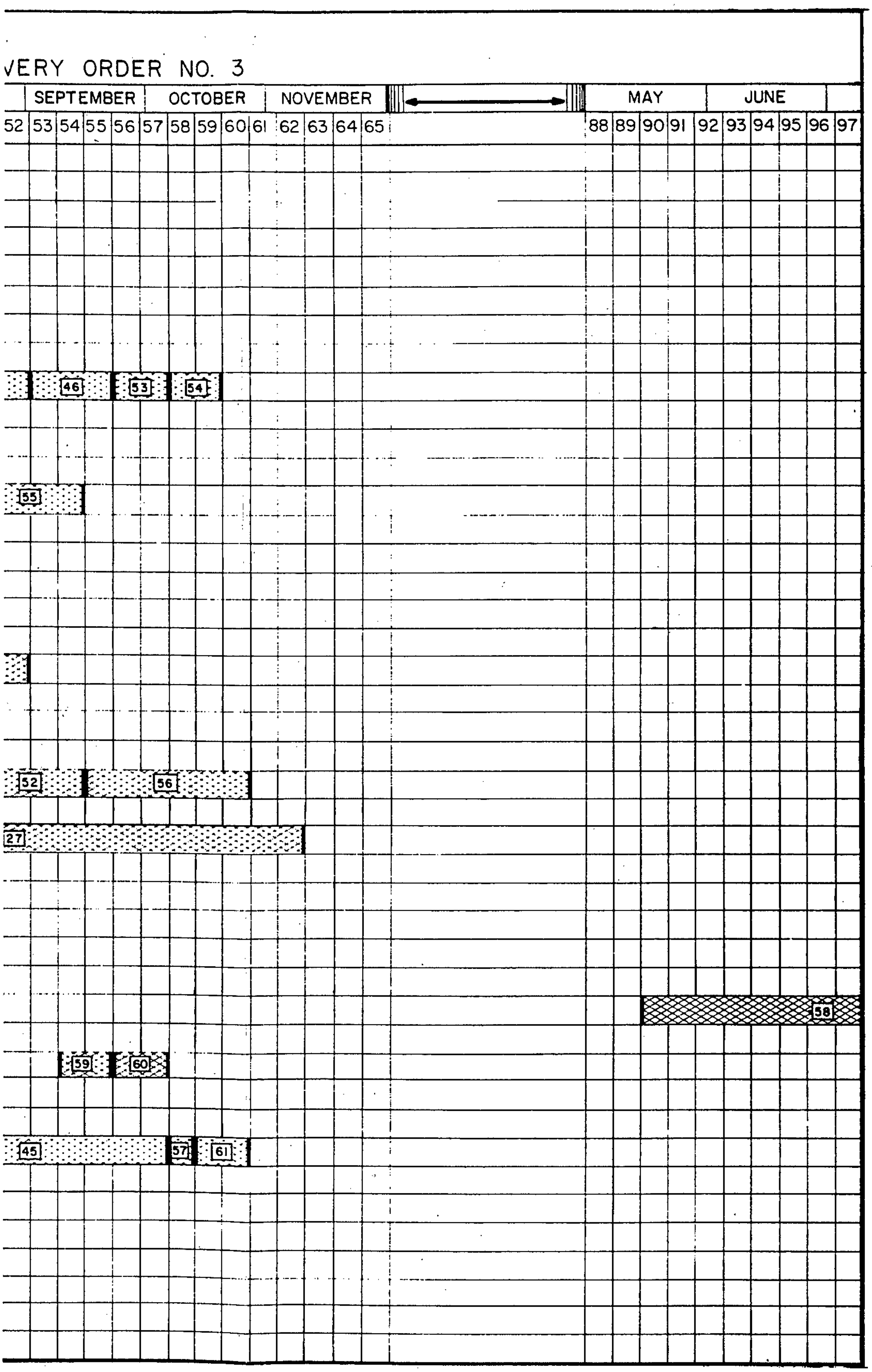

VERY ORDER NO. 3
SEPTEMBER
OCTOBER
NOVEMBER
MAY
JUNE
52 53 54 55 56 57 58 59 60 61 62 63 64 65
88 89 90 91 92 93 94 95 96 97
46
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EXHIBIT "D"

APPENDIX F

RECREATION, LANDSCAPE DEVELOPMENT, AND AESTHETIC CONSIDERATIONS

APPENDIX F

TABLE OF CONTENTS

APPENDIX F

RECREATION, LANDSCAPE DEVELOPMENT, AND AESTHETIC CONSIDERATIONS

RECREATION

1. A bicycle trail has been incorporated into the project as a recreation feature that will be cost shared. The trail is an 8-foot-wide asphalt-surfaced link between existing trail segments. The trail system will receive both recreational and transportation use. In addition, the trail will provide a maintenance access road for the flood control project.

2. The trail begins in Silver Lake Park on the right bank at Seventh Street N.E. A trail underpass will be built at the Seventh Street N.E. bridge and the Center Street bridge. The trail crosses Silver Creek on an existing pedestrian bridge and continues upstream to an underpass at the Center Street bridge. An at-grade crossing is at the railroad tracks at station 175+00. Above Center Street, the trail follows an existing street that parallels the river and will link with the new project trail at station 193+00.

3. The new trail will continue through Mayo Park to Fourth Street S.E. It will follow Fourth Street S.E. and will use the street bridge to cross Bear Creek. The new trail will follow the left bank of Bear Creek downstream to the Zumbro River and will continue upstream along the river to stage limits at Third Avenue S.E.

4. Park shelters will be built at stations 201+00 and 195+50. A specific shelter design will be developed in the plans and specifications for Stage 1A2. Toilet needs for trail users will be accommodated by existing park facilities.

5. Details relating to railing needs along the trail at riprap areas and underpasses will be determined during preparation of plans and specifications. Railings need to meet traffic control and safety requirements of a bicycle and pedestrian trail. During preparation of plans and specifications, the trail design and details will be evaluated for consistency with guidance in EM 1110-2-410, Design of Recreation Areas and Facilities - Access and Circulation, Department of the Army, December 31, 1982.

LANDSCAPE DFVELOPMENT AND AESTHETIC CONSIDERATIONS

6. In its 23 January 1987 letter, the city of Rochester expressed concern about aesthetics and the landscape development plan. A copy of this letter is in appendix G.

7. A landscape development plan has not been completed for this feature DM. A landscape concept plan will be developed before preparation of plans and specifications; it will be completed during plans and specifications.

13. Without changes to the basic feature DM design, additional background plantings at the park's right bank would provide some visual compensation for viewers using the park. Foreground plantings along the left bank would be designed to add visual diversity and interest while not barring or physically restricting views of the river channel or right bank.

APPENDIX G

CORRESPONDENCE

January 23, 1987

Rochester, Minnesota 55901

Chuck Hazama
Mayor

Colonel Joseph Briggs, District Engineer
U.S. Army Corps of Engineers
St. Paul District
1135 U.S. Post Office & Customs House
St. Paul, Minnesota 55101-14799

RE: ROCHESTER FLOOD CONTROL PROJECT/STAGE 1B FDM RECREATION AND LANDSCAPE CONCERNS

Dear Colonel Briggs:

During 1986 the City has had a number of discussions and meetings with Corps of Engineers staff concerning the Feature Design Memorandum for Stage 1B of the South Fork Zumbro River Flood Control Project. In those discussions, City representatives have expressed a number of concerns regarding some design aspects of the Stage 1B Feature Design Memorandum plans.

These concerns primarily related to the extensive use of riprap material in Stage 1B, especially in the area along both banks of the Zumbro River adjacent to the Mayo Civic Center and on the east bank of the Zumbro River from Center Street to the Seventh Street N.E. bridge. The City believes that some further review and study of landscape or design alternatives in those areas is in order.

We would, therefore, request either that such study be conducted prior to completion of the Stage 1B FDM or that some assurance be provided by the Corps that the City's concerns regarding the landscape design aspects of the Stage 1B FDM can and will be studied, with the active involvement of the City, between the Stage 1B FDM and the Stage 1B Plans and Specifications stages.

The City would also wish to have active and early involvement in the preparation of the FDM plans for the subsequent stages of the project. The City would request an opportunity to work with the Corps staff or the A/E firm retained to prepare the FDM for the next stage, Stage 2. As joint partners in this project, cooperation and coordination in the earliest stages of plan preparation will facilitate timely implementation and construction of the project.

Sincerely,

Chuck Hazama

Chuck Hazama
Mayor